Draft Scoping Information Document

Headwaters of the Upper Mississippi River, Minnesota
Reservoir Operation Plan Evaluation

May 2004

INTRODUCTION

DOCUMENT PURPOSE

The purpose of this document is to provide interested parties with the information needed to assess and comment on the scope of the Headwaters Reservoir Operation Plan Evaluation (ROPE) as it is currently being planned. With the information provided here, interested parties will be able to provide additional input regarding the scope of the study to ensure that all interests are adequately addressed within the Environmental Impact Statement (EIS).

The objectives of this document are threefold: 1) To list and discuss the currently known problems and opportunities found within the Headwaters of the Upper Mississippi River (HUMR) that are related to water-level management; 2) To briefly discuss the existing condition of the various resources of the HUMR, and to discuss those that would likely be affected by water-level management in more detail; 3) To briefly discuss the probable condition of those resources in the future 25 years from the present if water-level management practices do not change from the current condition.

This document will be made available to the general public, State, Federal, and local agencies, and Indian tribes prior to scoping meetings that are scheduled for the week of June 7, 2004. Topics in this document are covered briefly. Much of this document will later be revised with the inclusion of greater detail and supporting evidence and will eventually be included in the draft EIS for the ROPE. The results of the scoping process will be documented and made available for public review.

WHAT IS ROPE?

The U.S. Army Corps of Engineers and the U.S. Forest Service are embarking on a jointly sponsored, long-range reservoir operating plan study for the Mississippi River Headwaters reservoirs. This study is called the Reservoir Operating Plan Evaluation, or ROPE. The primary purpose of the study is to evaluate alternative plans for each of the existing reservoirs and try to improve system-wide operations of the Mississippi Headwaters reservoirs system. Consideration will be given to tribal trust, flood control, environmental concerns, water quality, water supply, recreation, navigation, hydropower, and other public interests when evaluating alternatives. Some possible outcomes could be lake level changes, winter drawdown changes, restoration of some sections of river systems, a more natural flow release for downstream river reaches and, in some lake areas, changes in flood control concerns for differing sections of the total system and possibly even the purchase of some land for maximizing efficient operation. The Minnesota Department of Natural Resources (MDNR), Ottertail Power, and Minnesota Power are collaborating Headwaters dam operators included in this planning effort and are helping to evaluate and recommend a system-wide operational plan for the Headwaters reservoirs. The Mississippi Headwaters Board and the Leech Lake Band of Ojibwe also play important roles in this

study by helping to coordinate and evaluate alternative plans from the regional perspective. The study began in December 2001 and should be completed by 2005.

The study process used for the ROPE relies heavily on interagency and public groups to assist in the plan formulation. Accordingly, there are numerous interagency task forces and local lake groups, and these volunteer groups will meet periodically to provide technical and public inputs and perspective. The general public will also be kept informed and involved in the study and will be asked to review a number of preliminary reports as alternatives are formulated and evaluated. In addition, there could be other spin-off projects and beneficial activities in the Headwaters area as a result of this study process.

Much more information is available at any of the Headwaters Corps of Engineers field offices or at the Website for this study located on the Internet at: http://www.mvp.usace.army.mil/fl_damage_reduct/default.asp?pageid=143

WHAT IS AN EIS AND SCOPING?

The National Environmental Policy Act of 1969 (NEPA) requires Federal agencies to carefully consider all environmental effects of their proposed actions. If a Federal action is likely to have a significant effect on the quality of the environment, the agency proposing the action is required to prepare an EIS. An EIS is a document that contains many components, some which are: a description of the proposed action and alternatives to the proposed action; a description of the affected environment in its present and future states; and a description of the environmental consequences of each proposed and alternative action.

Following the decision that an EIS is required, there are a number of steps that must be followed. The first step is scoping, a process that involves the participation of Federal, State, and local agencies, Indian tribes, and the general public. The most important thing that occurs during scoping is the identification of relevant and significant issues that will be analyzed in depth in the EIS. The scoping process is officially announced in the Federal Register through a Notice of Intent to prepare a Draft Environmental Impact Statement (DEIS).

Information gathered during scoping is used to prepare the DEIS, which is subsequently made available for agency and public comment. Also during this time, public hearings are held to further encourage public comment. Following the comment period, a Final EIS (FEIS) is prepared that identifies the agency's "preferred alternative". The FEIS is also made available for agency and public comment. Subsequent to this comment period, a Record of Decision (ROD) is prepared that states the agency's final decision. The ROD must also identify the environmentally preferable alternative, discuss how and why the agency reached its decision, and indicate whether all practicable means to reduce environmental harm have been included in the preferred alternative, and, if not, why not.

For the ROPE, it has been determined that an EIS will be prepared. The Notice of Intent was published in the Federal Register on December 12, 2003. For the ROPE EIS, the Corps of Engineers will act as the lead agency and the U.S. Forest Service will act as a cooperating agency. This means that the Corps of Engineers has the main responsibility for coordination and preparation of the EIS, but the U.S. Forest Service will play an active role in the preparation and funding of the EIS and the ROPE study in general.

KNOWN PROBLEMS AND OPPORTUNITIES

Through previous efforts, a great deal of information has been gathered regarding resources and how they are being affected by current water-level management. Specifically, information on current problems that need to be resolved and opportunities for improving conditions have been collected as a way to focus the study.

In January 1999, the St. Paul District, Corps of Engineers, in close cooperation with the Mississippi Headwaters Board, conducted a series of scoping meetings with the public and interested agencies in an effort to identify water resources problems and opportunities in the Mississippi River Headwaters area. These meetings occurred on 5 January 1999 in Grand Rapids; 6 January 1999 in Bemidji; 20 January 1999 in Brainerd; and 21 January 1999 in St. Cloud. Also, meetings with the Leech Lake Band and the Mille Lacs Band occurred on 22 January and 10 February 1999, respectively. Information from these meetings was consolidated into a letter report that was subsequently used here.

During the past two years, various agency and lake group meetings have been held as a way to provide ROPE information to the public and to gather additional information on known problems and opportunities. That information has been summarized here in addition to that from the letter report. In most cases the intention of each comment gathered was clear. However, in some cases the intention of a comment was unclear. For those comments a statement requesting some clarification is included with the comment in italicized text. Also, comments have been added to some problem and opportunity statements to provide clarification.

INDIVIDUAL RESERVOIRS

Bemidji and Irving Lakes

Problems:

- Shoreline erosion is occurring around the lake.
- High lake levels that occur periodically flood docks and some structures.
- Releases from the Stump Lake Dam in combination with high water levels downstream cause flooding in Wolf, Andrusia, and Big Lakes. The balance of flooding between these upstream and downstream areas is a local issue.

What is meant by "local issue" (does this mean we are not considering the issue?)? The problem can be traced all the way down to Winni. Flooding in Wolf, Andrusia and Big Lake are also a function of high water on Winni which raises Knutson Dam's tailwater and causes high water on the Cass chain.

Opportunities:

- Ottertail Power desires to be included in the system-wide reservoir evaluations and is an active stakeholder/operator in the ROPE study.

Cass Lake Chain of Lakes

Problems:

- Approximately 9 percent of the total shoreline on Cass Lake *(the entire chain of lakes or just Cass?)* and 11 percent of the shoreline on Pike Bay are actively eroding.
- Lake levels are higher and more stable than historic levels, affecting erosion, recreation, riparian vegetation, heritage sites, and aquatic and riparian dependent species.

Opportunities:

- To develop an environmental analysis to determine and disclose effects of shoreline erosion on Cass Lake and Pike Bay and provide a course of action for those shorelines.
- To inform the public about the only two aquatic invasive species in the watershed - this can be achieved by increasing awareness and signage.
- *Is there a goal of replacing Knutson Dam with a potentially more efficient structure that might increase outlet capacity?*

Lake Winnibigoshish

Problems:

- Lake Winnibigoshish has had shoreline erosion problems.
- Decreasing habitat for terns.
- Decreasing walleye habitat.
- *Is the operation for wild rice on Winni a problem?*
- The shoreline characteristics have changed drastically from the early 1800's, once being dominated by forested wetland communities including white cedar and tamarack.
- Flood control operations at Winnibigoshish affect the Cass Lake Chain of Lakes because Winnibioshish backwaters into Knutson Dam, thereby reducing outflow capacity.

- Combined releases from Winnibigoshish and Leech are restricted to 2,200 cubic feet per second (cfs). Is this restriction still needed under current conditions? How large a flow would be allowed under downstream flowage rights?

Opportunities:

- There is the opportunity to produce a new rule curve for Lake Winnibigoshish.

Is "rule curve" intended to be operating bands/limits or is the reference to the Aitkin "rule curves" (which include Winni by inference only)? "Rule curves" or "guide curves" should be used when specifically referencing Aitkin operations. See later comments on flood control guide curves.

- Could use drawdowns to promote the environment and habitat.
- To analyze and review how operations for fish spawning are working.

Leech Lake

Problems:

- The Leech Lake dam has channel inlet restrictions, and there are backwater issues for lakes with tributaries to the Mississippi.

This is not clear. Leech Lake is in the Leech Lake River subbasin. Which lakes with tributaries to the Mississippi is the reference to (perhaps Ball Club?). If Ball Club…then this is also an issue for Winni.

- Changes to Leech Lake will have impacts on Mud and Goose Lakes, where there are concerns regarding wild rice beds along with Leech.
- *Is shoreline erosion a problem?*

Opportunities:

- There is the opportunity to produce a new rule curve for Leech Lake, along with producing a new 5-year conservation plan using wild rice and other critical habitat areas as key factors.

See previous comments on rule curves.

Pokegama Lake

Problems:

- There is an inaccurate rule curve for flood protection at Aitkin; the economics of protecting farmland is the issue.

Same "rule curve" comment as above applies. We will not know if it is inaccurate until we analyze it. We only have anecdotal evidence that it MAY BE inaccurate. Are we sure that farm land value is the major issue?

- There are shoreline erosion problems on the lake.

- Pokegama cannot operate for flood control in Aitkin without the assistance of Winnibigoshish and Leech Lakes; those lakes need to be mentioned in the guide curves.

Opportunities:

- A new rule curve could be produced.

See previous "rule curve" comments.

- The lake could be drawn down at different times to promote different types of habitat and possibly eliminate some of the shoreline erosion problems.
- To determine if a maximum discharge guideline is needed (currently there is not one).

Sandy Lake

Problems:

- There is an inaccurate rule curve for flood protection at Aitkin; the economics of protecting farmland is the issue.

See the previous "rule curve" comment under Pokegama.

- On the lake, there are backwater issues during high water.

What does this refer to? Is it the backwater up the Sandy River or the Mississippi River backwater in the tailwater?

- For a large portion of floods, it is not possible to operate Sandy in accordance with the guide curves. In essence, Pokegama ends up being operated in an attempt to control Sandy's tailwater.
- The upper limit of the Federal flowage right at Sandy Lake is easily exceeded during years of high water.

Opportunities:

- There is the opportunity to produce a new rule curve.
- Change when winter drawdowns take place, potentially enhancing the habitat around the lake.

Pine River Dam/Cross Lake Reservoir

Problems:

- There is ice damage on the north shoreline.
- There are obstructions in the connecting channels that make navigation difficult.

Opportunities

- The role of Pine in flood control can be better defined or updated.
- Analyze and review how operations for fish spawning are working.

- Determine if the drawdown target is still a viable target.

Gull Lake

Problems:

- The flowage rights are equal to the upper operating limits.
- There are issues with the water levels and how sand bars have formed between the chain of lakes, making navigation hazardous. A higher summer band may alleviate this problem.

Opportunities:

- There is the opportunity to coordinate better with Sylvan and Little Falls dams and look at how the water levels affect the habitat.
- To determine if the drawdown target is still a viable target.

System-Wide

Problems:

- The Headwaters reservoirs and the Mississippi River face degradation of water quality and supply, possibly linked to population growth and how the dams on the system are operated.
- Due to the unnatural flow regime, there is an increased amount of lake and river erosion, increasing sedimentation and channeling in the system including tributaries.
- There is a reduction in channel complexity and a loss of functioning floodplain due to channel modifications.
- The unnatural flow regime impedes the restoration of aquatic and associated fish and wildlife habitat; these impediments point to a need to assess the overall ecosystem restoration needs of the Headwaters area.
- There are many land and water use development pressures that can lead to increased levels of pollutants.
- Minneapolis and St. Cloud are dependent on the water supply and do not have emergency water supply plans. St. Paul and Brooklyn Center also use the water but have alternate sources to fill some of the capacity (but perhaps not?).
- There has been a loss of habitat diversity and littoral vegetation in the system.
- The hydrologic cycle of the reservoirs affects fish spawning (particularly whitefish), rearing, and over-wintering, mussels, meadows, and floating bogs, while the dams act as barriers to movement for aquatic species.
- Increases in water levels in the Headwaters could flood septic systems and destroy some infrastructure, which are located within the flowage rights areas. There would also be possible increases in erosion.
- It is not known if the Flood Control Guide Curves used to manage flooding which were last updated in the 1950's are a good representation of current conditions.

However, due to significant changes in population distribution in the study area and greater public uses of the lake areas, it is likely that the guide curves need some revision.

- It is not known how the economic impact (including environmental) of storing water in the reservoirs compares to the damages prevented in Aitkin.
- It is not known how the effects (economic and environmental) of releasing water in the fall and winter compare to the damages prevented in Aitkin.
- If there are changes to the current water control plan, the potential changes to the 7Q10 flows will need to be assessed in particular locations for wastewater treatment plants, along with the economic impacts on those effects.
- Ball Club Lake is subject to flooding when the Mississippi River is high.
- Steam generation and nuclear power plants use the river water for cooling purposes. Low flows or high water temperatures can limit the amount of power that can be generated, posing a potential problem for the Twin Cities metropolitan area.
- If there are changes to the water control plan changes to the total maximum daily load (TMDL) in affected rivers will need to be considered.
- Changes to the drawdown plan will affect hydropower. The potential changes to flow duration (high and low) at particular locations will need to be evaluated, as well as the economic impacts on the hydropower plants.
- Changes to the water control plan will need to consider the impacts on the Whitewater Park, lock and dam operations, and the aesthetics of flow over the spillway at Upper St. Anthony Falls Dam.
- The regulations regarding Congressional Notification water level limits (WRDA 1988, P.L. 100-676) (see Table 2) need to be modified to account for errors in the language and dam safety modification

Opportunities:

- Due to the willingness of the Corps of Engineers, the U.S. Forest Service, the MDNR, Minnesota Power, and the Ottertail Power Company expressed desires to work together to implement system-wide operational improvements. There is an opportunity to operate all the dams in the Headwaters of the Upper Mississippi River (HUMR) as a system to more effectively manage water resources (i.e., There is an opportunity to improve the communication between Corps and non-Corps dam operators. These communications could be used to operate the system in a way that can better address and solve water resources problems).
- There is an opportunity to work with the Leech Lake and Mille Lacs Bands to clarify how the Government can meet its Tribal Trust responsibilities and where possible to identify Tribal interests that can be enhanced as part of reservoir operation.
- The role of each reservoir in flood control can be better defined or updated.
- There is an opportunity to develop operating plans that could achieve more natural flows and flux of water levels, mimicking nature, while improving both lake and river habitats (i.e., Restoration of ecosystem function, structure, and

dynamics could restore a more naturalistic, functioning, and self-regulating system that would protect critical resources from degradation).

- Current understanding of instream low flow requirements and rate of change flow rates is now better than when they were last established by the managing agencies in the 1970's. As a result, refinements to the low flow and rate of change flows are possible.
- There is a better understanding of how drawing down the reservoirs affects shoreline ice damage, and this current understanding will be valuable in assessing drawdown requirements.
- There have been extensive studies done to evaluate how effective Headwaters reservoir releases are managed during droughts to supplement water supplies in the Twin Cities. These studies clearly show that releases made from the Headwaters lakes do not reach the Twin Cities during drought conditions and are not effective means of supplementing the downstream water supplies. This new information will aid in evaluating alternatives evaluations for drought conditions.
- If this study recommends actions that would return the flow regime to a more natural condition, there is an opportunity to monitor the effects of such an operating plan in such a way as to research, demonstrate, and document effectiveness of such restoration actions.
- There is an opportunity to coordinate and institutionalize an adaptive management approach to water management and restoration efforts. This approach would monitor project performance and fully network adaptive operational measures to help attain desired operational outputs recommended by the ROPE study.
- There is an opportunity for improved public input and public education to create a learning laboratory for students and practitioners on issues related to how the reservoirs are to be operated including: best land management practices and water resource stewardship.

RESERVOIR OPERATION ALTERNATIVES

There are a number of possible alternative operating plans that will be integrated into the plan formulation and screening process. Each alternative operating plan will be created using combinations of different operational components at different reservoirs. It would not be possible to list all possible alternatives at this time but it is possible to list the components that will later be combined to create alternatives. The operational components listed here have been identified as the result of past interagency/public inputs, recent coordination with stakeholders, and professional knowledge from the Corps of Engineers Project Team. Additional operational components will likely be identified as a result of the scoping process. The key operational components to be evaluated in different combinations for some or all reservoirs include:

- No Action or no change to current conditions (maintain the status quo).
- Reduce flood damages and balance upstream and downstream trade-offs to foster fairness.

- Continue to operate for flood control at Aitkin, Ball Club Lake, and other places.
- Do not operate for flood control at Aitkin, Ball Club Lake, and other places.
- Operate with different drawdown levels and/or eliminate the drawdown.
- Change the channel capacity restrictions between Winnibigoshish/Leech and Pokegama (restriction is currently 2,200 cfs). How does raising the 2,200 cfs value affect high water on the Cass Lake Chain? (It should help.)

The 2,200 cfs rule was implemented to limit the problems at Little Winni, Ball Club, Mud and Goose, White Oak as well as private residents and businesses in the reaches above Pokegama. To clarify - "do not operate for Ball Club" (see above) implies that we ignore the 2200 rule.

- Operate to mimic nature (e.g., produce high flow in the spring and low flow in the fall) to enhance natural resources.
- Conduct periodic and selective drawdowns on reservoirs (e.g., like what was done at Pool 8 on the Mississippi River to simulate drought) to enhance aquatic vegetation.
- Operate to improve and/or optimize recreation opportunities throughout the study area and minimize adverse effects to current recreation users.

EXISTING CONDITION

STUDY AREA

The setting for the ROPE is the Headwaters of the Upper Mississippi River Basin above Lock and Dam 2 at Hastings, Minnesota, not including the Minnesota River Basin (Plate 1). The study area is limited to the reservoirs, lakes, rivers, and adjacent floodplains and wetlands that would be affected by changes in the operation of the study reservoirs. Lake Bemidji, Cass Lake, Lake Winnibigoshish, Leech Lake, Big Sandy Lake, Whitefish Lake Chain, and Gull Lake are the main reservoirs included in the ROPE. Furthermore, the effects on numerous connected lakes will also be included in the ROPE. Additionally, the study area also includes the Mississippi, Leech Lake, Sandy, Pine, and Gull Rivers, and the areas adjacent to those rivers that would be affected by operational changes.

PHYSICAL SETTING

The Mississippi River is one of the most commonly known geographic features of the world, and it has played a prominent role in the shaping of our country. From its start at Itasca State Park, the Mississippi River flows south 2,350 miles, to the Gulf of Mexico. The Headwaters of the Upper Mississippi River Basin, as defined by this study, starts in Itasca State Park and runs a generally northeasterly course to Bemidji, then east to Grand Rapids before turning south and running through Brainerd, Little Falls, St. Cloud, and the Twin Cities metropolitan area before it combines with the St. Croix River below Lock and Dam 2 near Hastings. As the river runs its course through the HUMR, it drains a mixture of forests, prairie, agriculture, and urban land areas.

Geology and Soils

The upper portion of the study area lies in a region of geologically young, gray, glacial drifts from the Keewatin Center, which, in the Grand Rapids, Minnesota, area, become a thin veneer over a rugged moraine of Patrician or young red drift. Sandy, Pine River, and Gull Lakes lie in the red drift region. The gray drift is generally more clayey and less stony than the red drift. The drifts vary in thickness from 300 to 400 feet at the head of the Mississippi River to about 200 feet near Gull Lake.

Cass County contains three of the Corps dams (Winnibigoshish, Leech, and Gull) and comprises 1,998 square miles of gently rolling upland surface and numerous lakes. This topography is the result of deposition of glacial drift during the Wisconsin Age. Three general types of deposition are found in Cass County. In the north, along the south shore of Lake Winnibigoshish, is a sandy outwash plain. South of this outwash, near Leech Lake, is a substantial zone of glacial till plain. The southwestern portion of the county, from Leech Lake to northern Gull Lake, is part of the St. Croix moraine system.

At least 16 distinct types of soil are recorded in Cass County. The outwash of the northern part of the county has developed a very light-colored, loamy sand with low inherent agricultural fertility. The soils in the remainder of the county are mixtures of sand, clay, and loam of fair to good fertility. Organic peat soils occur in numerous low-lying areas throughout the county. These soils have good fertility potential but present problems in physical structure and water holding capability.

Aitkin County, in which Sandy Lake is located, is predominantly glacial till plain with a large outwash area immediately to the northeast characterized by surface deposits of sand and gravel. The soil of the glacial till plain area is brownish and slightly acidic, with pebbles and boulders of granite and gneiss.

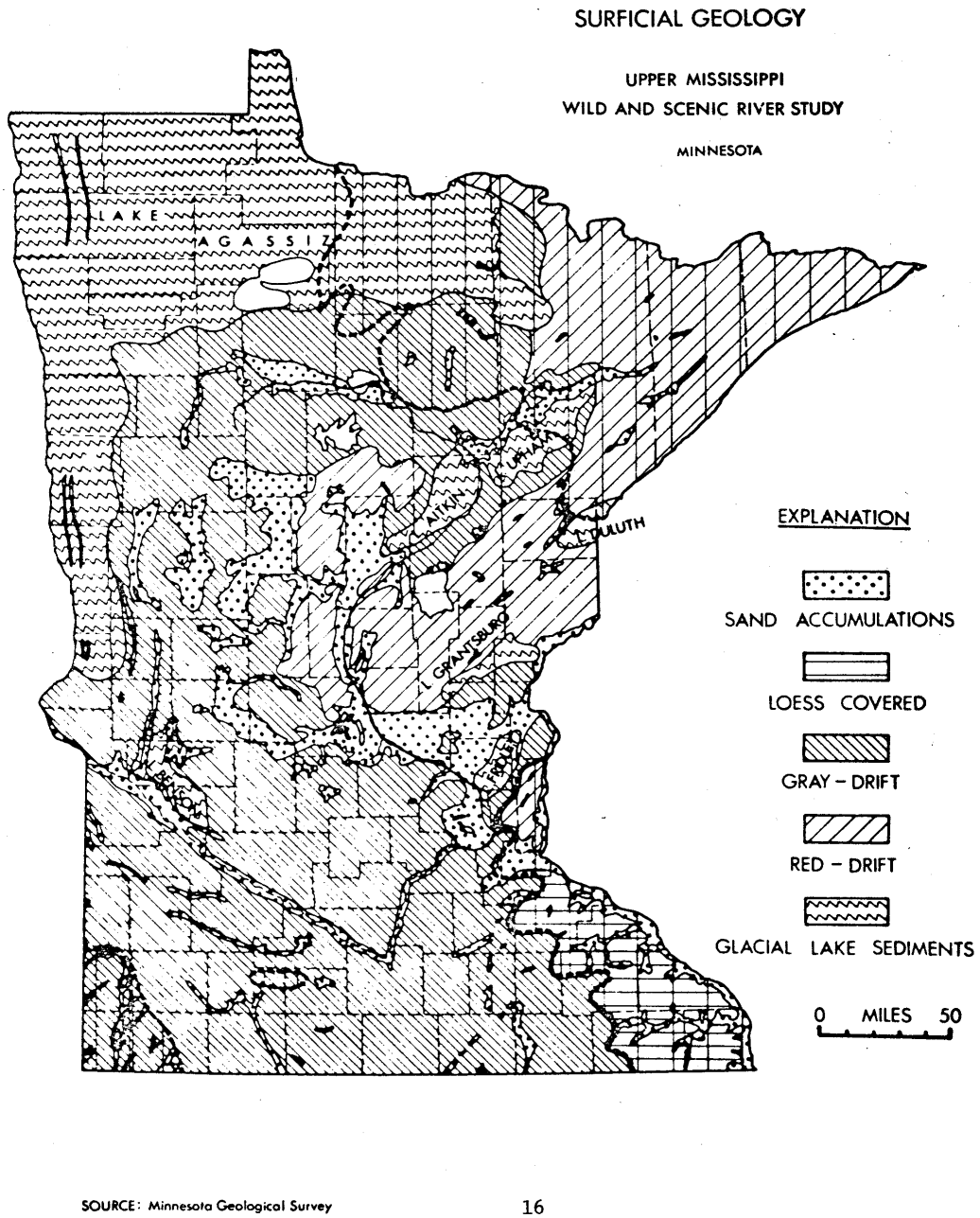
Crow Wing County, in which the Whitefish Lake chain is located, consists primarily of glacial outwash, with considerable moraine along the eastern border and till plain along the southern margin. Pine River Lake is located on outwash soils dominated by sand and clay with fair to poor fertility.

Itasca County, in which Pokegama Lake is located, is characterized by surface features resulting from the Wisconsin glaciation over 10,000 years ago. The soils are diverse. Loamy sands characterize the east central and west central portions of the county. Silty lake sediments occur in several townships. Erosion-prone sand and peat deposits of low fertility occur in the southeastern part of the county, and a belt of reddish clay loam extends from the southwest to the northeast.

Veins of gravel and sand are located throughout the Headwaters region, especially in the gray drift areas. These veins permit free interchange of water between the Headwaters lakes and the underground water table. Sand and gravel deposits are found extensively in

Cass, Crow Wing, and Itasca Counties as well as in and around Minneapolis and St. Paul, Minnesota, at the southern extreme of the study area. Figure 1 shows the surface geology of Minnesota.

Figure 1. Surface Geology of Minnesota



The Mississippi River basin contains two iron ore ranges, the Mesabi and Cuyuna. In Itasca County, the Mesabi Iron Range extends northeast to southwest across the prairie and the Mississippi River, passing through and terminating several

miles southwest of Grand Rapids. The Cuyuna Iron Range runs parallel to the Mississippi River and then crosses it near the center part of the eastern border of Crow Wing County. Iron ore reserves in the Mesabi Range contain four major types: natural ore, nonmagnetic taconite, magnetic taconite, and semitaconite. The Cuyuna range has large reserves of nonmagnetic, low-grade ores.

Sedimentation/Bank Erosion

The shorelines of some or all of the Headwaters lakes have likely not yet stabilized at the higher water levels created by impoundment about a century ago. Shoreline erosion is a significant problem on some of the lakes, especially Lake Winnibigoshish and Cass Lake. Loss of shoreline habitat, property, scenic beauty, and redistributed sediment covering rocky lake bottom are all adverse effects of continued shoreline erosion. Some of the eroding shorelines threaten cultural resources sites. Some of these areas have already been stabilized with rock.

Climate

The climate found in this region is considered the continental type that does not benefit from the moderating influences of the earth's oceans. Large annual temperature ranges characterize this type. Winters are most often long and cold. The warmer summer months are generally mild, but may contain periods of excessive heat and humidity.

Freezing temperatures usually prevail from mid-October to mid-April. The mean annual precipitation including melting snow is approximately 28 inches. Approximately 18 inches of this occurs during April through September. This is summarized by Table 1, which shows the average maximum and minimum temperatures, and the average rainfall for every month of the year for Bemidji, Brainerd, and Minneapolis. These can be considered the northernmost, the middle, and the most southern zones of the study area. The growing season, or that length of time between the last frost in the spring and the first frost of the fall, over the region varies from 118 to 148 days. Crops are thus limited to those that can mature and be harvested during this period.

Precipitation is influenced by moisture from the Gulf of Mexico that combines with weather systems that generally come from the west since the prevailing winds are northwesterly. Precipitation occurs as rain, freezing rain, hail, and snow. Violent weather events often occur, but these are of short duration and affect relatively small areas. These events include tornadoes, severe thunderstorms, and hailstorms.

Table 1. Climate data for Bemidji, Brainerd, and Minneapolis.

Weather station **BEMIDJI, BELTRAMI CTY.** is at 47.45°N 94.86°W. Height about 1338 feet above sea level. Averaging records from 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	13.6	21	33.8	50.5	64.8	73.9	79.3	76.5	64.9	53.2	34.3	18.9	48.7
Min. Temp. °F	-8.8	-3.7	10.8	28	40.5	51.3	56.5	53.8	43.2	32.4	17.2	-0.7	26.8
Rain fall inches	0.6	0.5	0.9	1.8	2.6	3.9	3.4	3.5	2.5	1.8	0.9	0.7	23.1

Weather station **BRAINERD, CROW WING CTY.** is at 46.36°N 94.20°W. Height about 1177 feet above sea level. Averaging records from 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	18.1	25.2	37	53.2	67.3	76.1	81.1	78.3	67.6	56.3	38.1	23	51.8
Min. Temp. °F	-5.5	-0.3	13.5	29.8	41.5	50.7	56.3	52.9	43.2	33.3	19.2	2.5	28.2
Rain fall inches	0.8	0.7	1.3	2.1	2.9	3.8	4.4	4.3	2.3	2.1	1.4	0.7	26.8

Weather station **MINNEAPOLIS INTL AP, HENNEPIN CTY.** is at 44.88°N 93.21°W. Height about 833 feet above sea level. Averaging records from 1950 to 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	20.8	26.6	39.2	56.5	69.3	78.8	83.8	80.6	70.7	58.6	41	25.5	54.1
Min. Temp. °F	2.8	9.3	22.8	36.1	47.5	57.6	63	60.3	50.2	38.7	25.3	10.2	35.2
Rain fall inches	0.8	0.9	1.8	2.3	3.2	4.1	3.8	3.7	2.7	1.9	1.4	1	27.6

OPERATION/WATER CONTROL

Introduction

The guidelines, regulations, and general plan for operating the Mississippi River Headwaters reservoirs are contained, for the most part, in the 1963 (revised in 1968) Master Regulation Manual. However, various changes in the operation plans have occurred since the 1960's through either additional regulations from Congress or adaptive management. This section is provided as a summary of the current plan for use by parties interested in participating in the ROPE.

History, Headwaters Water Control Plan

General regulations governing the operation of the Mississippi Headwaters dams were first established by the War Department in 1889 and were formally modified in 1931, 1935, 1936, 1944, and 1988.

The area surrounding the Headwaters lakes was largely undeveloped (i.e., a wilderness) when the dams were first constructed in the late 1800's and early 1900's. Consequently, there were no serious objections to widely fluctuating lake elevations. During this period, it was not uncommon to store all of the spring runoff, which often resulted in very high lake levels.

During and after the first third of the 1900's, as recreation and the number of homes on the reservoirs increased and agricultural and urban development downstream began to occur, local landowner interests became more important in governing reservoir regulation. Resort owners and local residents organized and demanded the establishment of minimum operating levels to provide them with more reliable conditions. As a result, on February 11, 1931, following a request from the Minnesota Lake Levels Association, the Secretary of War revoked the 1889 regulations and issued the 1931 order. The new order included both high and low reservoir operating limits, minimum outflows, and minimum summer flows at St. Paul and other rules. Additional regulations were issued in 1935, 1936, 1944, and 1988 as additional issues surfaced.

The United States law that incorporates all the changes made through the 1944 order can be found in the Code of Federal Regulations, Title 33, Section 207.340, while the 1988 addition can be found in Public Law 100-676, Section 21 of the Water Resources Development Act of 1988. The reservoirs are also regulated according to regulations approved by higher authority (the Chief of Engineers) and guidelines from the Minnesota Department of Natural Resources. Tribal Trust is considered at all times.

The various regulations and guidelines governing the regulation of the Headwaters reservoirs are summarized below.

Mississippi River Headwaters, Water Control Plan Summary

Normal Summer Range/Band

The Summer Band represents the range of water levels that are the most beneficial to a majority of the users during the summer. The summer band widths are: 0.5 foot on Winnibigoshish, Pokegama, Sandy and Cross; 0.4 foot on Leech; and 0.25 foot on Gull. See Table 2, Row 1 and Table 3 for additional information on the summer bands.

Ordinary Operating Limits

In general, the Ordinary Operating Limits (see Table 2, Row 2 and Table 3) range from the normal winter drawdown level (see below) to the elevation above which erosion begins to accelerate in a particular reservoir. They are meant to be a range of elevations residents might expect to experience in an "ordinary" annual cycle. In actual practice, the lower elevations are reached in most years as part of the winter drawdown, however; depending on the reservoir, the upper limits are reached less frequently. At Leech, a normal drawdown elevation of 1293.80 feet has been found to be adequate as opposed to the listed value of 1293.20 feet. The limits are a narrower range contained within the Present/Total Operating Limits (see Table 2, Row 3).

Present/Total Operating Limits

These limits represent the absolute upper and lower limits within which the Corps is allowed to operate the reservoirs (see Table 2, Row 3 and Table 3). The Total Operating Limits originated from regulations issued by the Secretary of War between 1931 and 1944. The upper limits at Pokegama, Sandy, and Cross Lake were modified in later years. Pokegama and Sandy's upper limits were raised in the 1950's following the adoption of the spring and summer Aitkin Flood Control Guide curves (see below) to permit more storage for downstream flood control. Cross Lake's upper limit was raised in 2001 following the completion of the dam safety rehabilitation which raised the dam 4 feet. The lower limits represent the maximum winter drawdown levels, which can be used if the snowpack indicates that a drawdown to the normal "ordinary" levels (see below) will not be adequate.

Federal Average Annual Flow/Minimum Flow

The aforementioned regulations issued between 1931 and 1944 also contain required average annual flows from the reservoirs, which are related to the minimum Total Operating Limit (see Table 2, Rows 3 and 4). The regulation states:

"….the average annual discharge from the respective reservoirs shall not be reduced below the following values…" [listed in Table 2, Row 4]

"No discharge other than the minimum specified….shall be permitted when a reservoir is at or below its minimum stage [also listed in Table 2, Row 4]…*except such increase of discharge as may specifically be directed by the Chief of Engineers."*

In summary:

a. The specified average annual discharge must be released every year.

b. When the reservoirs are below the lower Total Operating Limit elevation, no discharge larger than the annual average value is allowed unless directed by the Chief of Engineers.

Note that there are cases where this regulation will conflict with the Minnesota Department of Natural Resources low-flow guidelines (see Table 2, Row 6 and discussion below).

Congressional Notification Levels

In 1988, Minnesota Governor Rudy Perpich asked the Corps of Engineers to make supplemental releases from the Headwaters reservoirs to meet downstream water use requirements. When rainfall returned to the region in early August 1988, the Corps denied the request. Congressman James Oberstar, however, determined that some Congressional oversight was needed related to the use of the water contained within the reservoirs for the benefit of upstream and downstream uses. As a result, the Congressman sponsored Section 21 of Public Law 100-676 (Water Resources Development Act of 1988). The law states that the Secretary of the Army must notify Congress 14 days in advance of any reservoir going outside the prescribed minimum and maximum operating limits. See Table 3 for additional information on the Congressional Notification Limits.

Low-Flow Guidelines, Minnesota Department of Natural Resources

After taking measures to insure that the average annual Federal discharge/volume/minimum flow requirement can be satisfied, the Minnesota Department of Natural Resources guidelines are followed (see Table 2, Row 6). The MDNR guidelines suggest minimum flow values if a reservoir is at or above the lower Federal elevation limits listed in Table 2, Row 3. Furthermore, if a reservoir is below the lower limit, the minimum discharge is reduced by half. However, during an extreme dry period, over the span of many months or years, the MDNR guidelines could conflict with the Federal average annual discharge requirement. The Federal regulations are primary. See Table 3 for additional information on the MDNR low-flow guidelines.

Table 2. Operating elevations.

Mississippi River Headwater Reservoir System Operating Elevations in 1929 NGVD and Stages in Feet						
	Winni-bigoshish	**Leech**	**Pokegama**	**Sandy**	**Cross L. Pine R.**	**Gull**
1. Normal Summer Range/Band Stage in Feet Middle of the Summer Band Elev.	1297.94-1298.44 9.0 - 9.5 1298.19	1294.50-1294.90 1.8 - 2.2 1294.70	1273.17-1273.67 8.75 - 9.25 1273.42	1216.06-1216.56 8.75 - 9.25 1216.31	1229.07-1229.57 12.75 - 13.25 1229.32	1193.75-1194.00 6.0 - 6.25 1193.87
2. Ordinary Operating Limits Stage in Feet	1296.94-1300.94 8.0 - 12.0	1293.20-1295.70 0.5 - 3.0	1270.42-1274.42 6.0 - 10.0	1214.31-1218.31 7.0 - 11.0	1227.32-1230.32 11.0 - 14.0	1192.75-1194.75 5.0 - 7.0
3. Present/Total Operating Limit Stage in Feet (2002)	1294.94-1303.14 6.0 - 14.2	1292.70-1297.94 0.0 - 5.24	1270.42-1278.42 6.0 - 14.0	1214.31-1221.31 7.0 - 14.0	1225.32-1235.30 9.0 - 18.98	1192.75-1194.75 5.0 - 7.0
4. Federal Regulations, Title 33, Min. Level and Ave. Annual Flow	1294.94 / 6.0 150 cfs	1292.70 / 0.0 70 cfs	1270.42 / 6.0 200 cfs	1214.31 / 7.0 80 cfs	1225.32 / 9.0 90 cfs	1192.75 / 5.0 30 cfs
5. Cong. Notification Levels, Public Law 100-676, Sect. 21, WRDA 88	1296.94/1303.14 8.0 / 14.2	1293.20/1297.94 0.5 / 5.24	1270.42/1276.42 6.0 / 12.0	1214.31/1218.31 7.0 / 11.0	1227.32/1234.82 11.0 / 18.5	1192.75/1194.75 5.0 / 7.0
6. MN Dept. of Natural Resources Minimum Flow Guidelines Min. Release Elevation, Stage and Minimum Flow	≥ 1294.94 / 6.0 100 cfs, < 1294.94 50 cfs	≥ 1292.70 / 0.0 100 cfs, < 1292.70 50 cfs	(See Note No. 6.)	≥ 1214.31 / 7.0 20 cfs, < 1214.31 10 cfs	≥ 1225.32 / 9.0 30 cfs, < 1225.32 15 cfs	≥ 1192.75 / 5.0 20 cfs, < 1192.75 10 cfs
7. Flood Operation, Control Points	Aitkin/Pokegama	Aitkin/Pokegama	Aitkin/Sandy	Aitkin	Ft. Ripley etc.	As Needed
8. Fish Spawn, Operation Guidelines	Fish Spawn	---------	---------	--------	Fish Spawn	--------
9. Flowage Rights Acquired To Elev.: Stage in Feet	1306.86 17.92 +	1301.94 9.24 +	1280.42 16 +	1222.31 15 +	1238.82 22.5 +	1194.75 7
10. Est. Downstream Chan. Cap., cfs	2,000	1,500	6,000	(8.)	2,000-2,500	950
Gage Zero Elev., 1929 NGVD	1288.94	1292.70	1264.42	1207.31	1216.32	1187.75

1. The most desirable levels for the summer season.
2. The Ordinary Operating Limits represent the range that minimizes the degree of high and low water damages. The lower limit is the normal drawdown target level for high snow water content, the exception being Leech which uses 1293.80.
3. The Present Operating Limits are in accordance with the latest regulations from Congress or subsequent studies. The upper and lower limits provide maximum storage for flood control and other purposes.
4. Title 33, Code of Federal Regulations, Sect. 207.340(d) prescribes the min. operating limits and min. aver. annual discharges as set forth in the 1936 and (for Leech) 1944 regulations.
5. Public Law 100-676, Section 21, of the Water Resources Development Act of 1988 requires the Secretary of the Army to notify Congress 14 days prior to a reservoir being below the minimum or above the maximum listed here. The District will notify the Secretary well in advance of the 14-day period.
6. The MDNR elev. and flows are based on an informal agreement between the Corps and the MN Dept. of Natural Resources and are followed after taking measures to insure the federal aver. annual flow requirement is met. When Pokegama is below elev. 1273.17 ft., releases are limited to the sum of the Winnibigoshish and Leech discharges. In addition, 200 cfs has been adopted as the minimum discharge when Pokegama is at or above elev. 1273.17 ft.
7. Flowage rights on the Cass L. Chain obtained to elev. 1307.86 (18.92 ft. stage).
8. The channel below Sandy Lake is affected by backwater from the Miss. River. The channel capacity below the confluence of the Miss. River and the Leech Lake River is 2,200 cfs. High flows in the 2,000 to 2,500 cfs range from Pine River Dam cause high water problems on Big Pine Lake.

Table 3. Sources for water control regulations.

Mississippi River Headwater Reservoir System Summary of Sources for Water Control Regulations and Guidelines (see also Table 1)				
	Code of Federal Regulations or Laws	U.S. Army Corps Of Engineers 1963 Water Control Manual	Minn. Dept. of Natural Resources Guideline	Notes
1. Normal Summer Range/Band		✓		See Note No. 1 Below
2. Ordinary Operating Limits		✓		See Note No. 2 Below
3. Present/Total Operating Limit	✓	✓ Pokegama, Sandy and Pine upper limits raised by St. Paul District studies		See Note No. 3 Below
4. Federal Regulations, Title 33, Average Annual Flow/Minimum Flow	✓	✓		See Note No. 4 Below
5. Cong. Notification Levels, Public Law 100-676, Sect. 21, WRDA 88	✓			See Note No. 5 Below
6. MDNR Minimum Flow Guidelines Min. Release Elevation, Stage and Minimum Flow		✓	✓ All 6 Reservoirs	See Note No. 6 Below
7. Flood Control		✓		See Note No. 7 Below
8. Guidelines For Fish Spawning			✓ At Winnibigoshish and CrossLake/Pine only	See Note No. 8 Below
9. Dam Rate-of-Release Guidelines for Gate Movements			✓ At Winni, Leech Pokegama and Cross Lake/Pine	See Note No. 9 Below
10. MDNR Max. Outflow Guideline		✓	✓	With the exception of Pokegama, See Note No. 10

1. The normal summer bands are published in the 1963 (rev. 1968) Headwaters Dams and Reservoirs, Master Regulation Manual. The Master Manual was authorized by the Chief of Engineers. See **Paragraph 1**.
2. The Ordinary Operating Limits and drawdown guidelines are published in the 1963 (rev. 1968) Headwaters Dams and Reservoirs, Master Reg. Manual. The Master Manual was authorized by the Chief of Engineers. See **Para. 2**.
3. The Present Operating Limits are in accordance with regulations from the Secretary of War and subsequent studies. The lower limits are listed in Title 33, Code of Federal Regulations, Sect. 207.340(d.7.). The upper limits are in a letter from the Acting Secretary dated May 14, 1935. The upper limits at Pokegama, Sandy and Pine were raised 2 ft., 3 ft., and 0.48 ft. respectively following subsequent St. Paul District studies (and approved by higher authority). See **Paragraph 3**.
4. The minimum average annual flow requirements are listed in Title 33, Code of Federal Regulations, Section 207.340(d.2.). The values are also minimum flows when the reservoirs are at or below the lower limits. See **Para. 4**.
5. Public Law 100-676, Section 21, of the Water Resources Development Act of 1988 requires the Secretary of the Army to notify Congress 14 days prior to reservoir water levels reaching specified limits. See **Paragraph 5**.
6. The MDNR low-flow elev. and flows are based on an informal agreement between the Corps and the MDNR and are published in the 1963 (rev. 1968) Headwaters Dams and Reservoirs, Master Reg. Manual. See **Paragraph 6**.
7. Winnibigoshish, Leech, Pokegama and Sandy are operated for flood control at Aitkin, MN. See **Paragraph** 7.
8. Winnibigoshish and Cross Lake have fish spawning guidelines. See **Paragraph 8**.
9. See **Paragraph 11.** Sandy and Gull do not have MDNR rate-of-release guidelines.
10. See **Paragraph** 7.5.3. Pokegama does not have a MDNR maximum flow guideline. See also **Paragraph** 7.5.1.

Operation for Flood Control

Winnibigoshish, Leech, Pokegama, and Sandy: Aitkin Flood Control

Winnibigoshish, Leech, Pokegama, and Sandy reservoirs are regulated for flood control at Aitkin, Minnesota. Pokegama and Sandy are operated according to Spring and Summer Flood Control Guide Curves for Aitkin (see Figures 2 and 3). However, this flood control operation is accomplished with the assistance of Winnibigoshish and Leech (where the largest amount of storage resides). Winnibigoshish and Leech also store water to assist Pokegama in accomplishing its final winter drawdown. All six of the reservoirs are regulated, if necessary, for other downstream flood-prone areas. Pokegama's curves are identical to the curves published in the Sandy Water Control Manual.

Cross Lake/Pine, Flood Control

The 1963 (revised in 1968) Cross Lake/Pine Water Control Plan states: *"The situation at stations on the Mississippi River from Fort Ripley to the Twin Cities shall be considered in determining the outflow. If protection from flooding is needed at any of these stations, the inflows shall be stored as necessary until [the] maximum operation limit… is reached."*

Gull, Flood Control

The 1963 (revised in 1968) Gull Lake Water Control Plan states: *"If it is necessary to store inflows for downstream protection, allow pool to rise to maximum and ordinary operating limit, elev. 1194.75 ft."*

Winter Drawdown

The reservoir water levels are lowered every winter to create room for flood control storage in the spring. The drawdown begins in the fall (September or early October) and concludes prior to the spring breakup. The drawdown is targeted for completion by February 28 with the exception of Winnibigoshish, Leech and Pokegama. The drawdown of Winnibigoshish and Leech is targeted for February 15 to allow time for reducing the outflows from the two dams in time to allow the final drawdown at Pokegama. The drawdown elevations are "targets". The actual drawdown elevation in any given year is adjusted as the extent of the snowpack reveals itself over the course of a winter. The final drawdown elevation can be higher, or in some cases lower, than the "normal" drawdown target (see below).

Normal Drawdown ("normal snowpack")

A normal snowpack constitutes approximately 3 to 6 inches of snow water content. The normal drawdown target elevations are the lower elevations of the Ordinary Operating Limits. The exception is Leech, where a normal drawdown

elevation of 1293.80 feet has been found to be adequate as opposed to the listed value of 1293.20 feet. In the case of Pokegama, Sandy, and Gull, the normal drawdown elevation is also the lower Total Operating Limit.

Figure 2. Guide curve for spring flood.

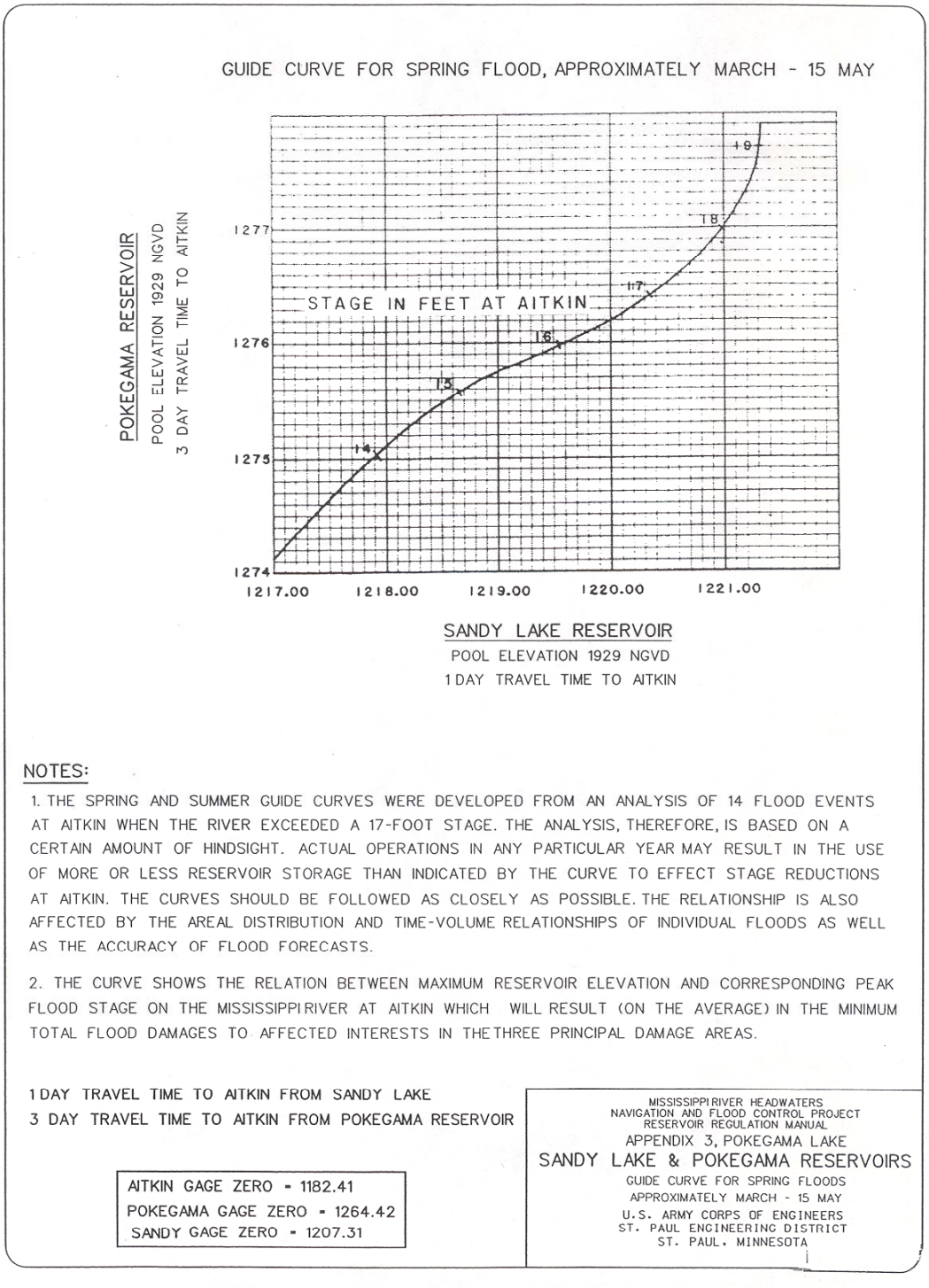
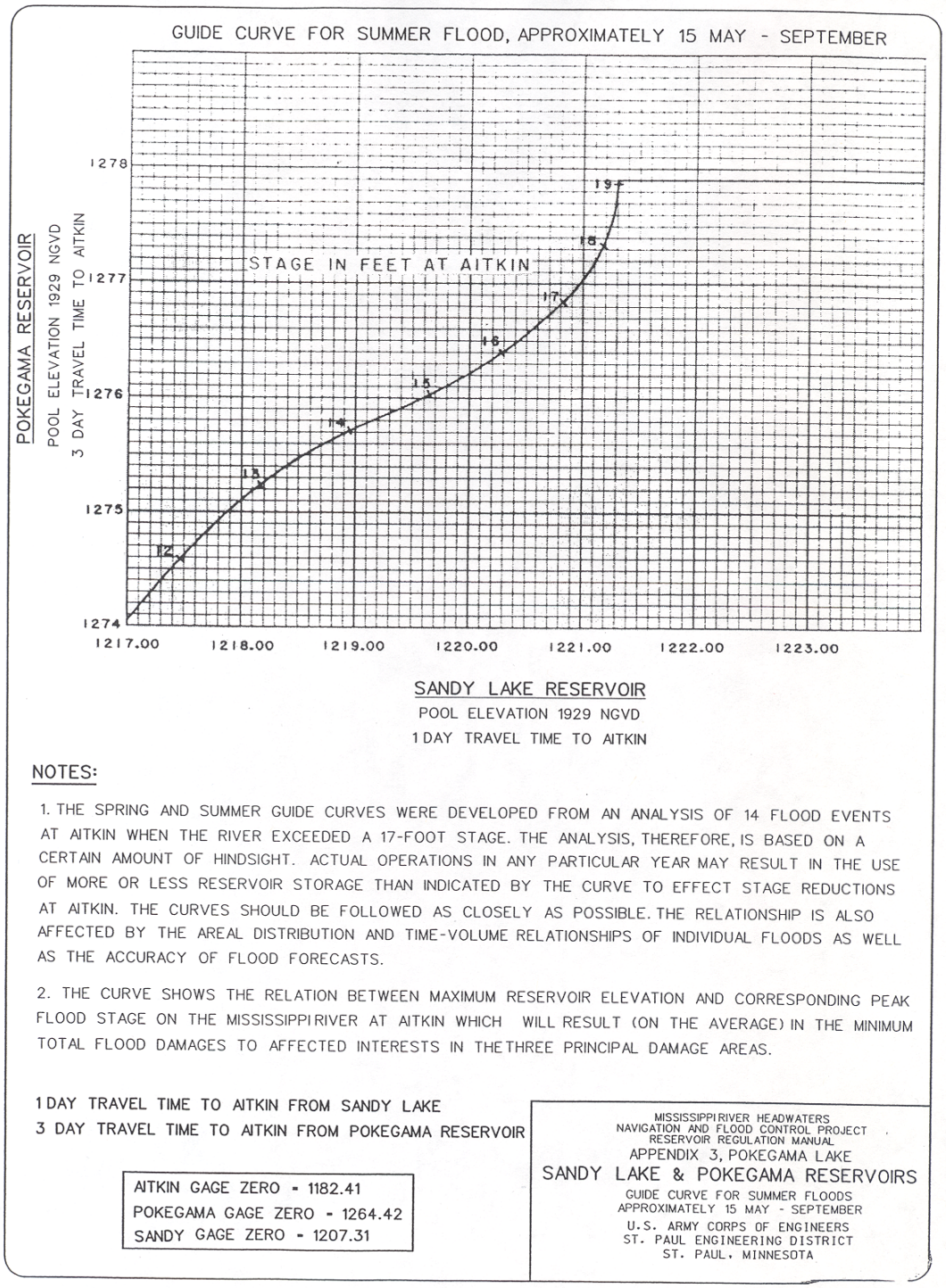


Figure 3. Guide curve for summer flood.



If, during the drawdown of Pokegama, the elevation at the Days High Landing gage approaches 1271.5 feet, before Pokegama Lake reaches its desired drawdown level, the discharge is reduced to maintain 1271.5 feet at the gage. This prevents the lowering of lakes and wetlands in the White Oak Lake area.

Extreme Drawdown (high snow water content)

If the water content of the snow is higher than normal, Winnibigoshish, Leech, and Cross Lake can be drawn down to the lower Total Operating Limit.

Additional Operational Characteristics

Winnibigoshish/Leech Outflow Restriction

The Corps has an informal agreement with local landowners and the MDNR that states that the combined discharge from Winnibigoshish and Leech will be limited to 2,200 cfs to alleviate flooding problems along the river reaches upstream of Pokegama. Property damage can occur along the Mississippi River as well as on adjoining lakes/flowages like Little Winnibigoshish Lake, Ball Club Lake, White Oak Lake and Mud/Goose Lake. Water can sometimes back up to the city limits of Deer River, Minnesota. The 2,200 cfs guideline is not in the official 1963 (revised in 1968) Master Water Control Manual (it was adopted later).

Sandy Outflow Restriction

Sandy's flood control operation is hampered by the backwater effect of the Mississippi River up into the Sandy River. During flood periods, the Sandy River below Sandy Dam, due to backwater from the Mississippi, can rise to a level that equals (or exceeds) the lake level. This reduces the amount of water that can be released from the dam (to zero in many years), which results in very high lakes levels (often exceeding the flowage rights elevation). As a flood is receding, an increase in the discharge from Pokegama (to evacuate stored water) is delayed so as not to prolong the recession of the Mississippi River levels in the Sandy area to aid in the lowering of Sandy's lake level.

Maximum Outflow Guideline, Minnesota Department of Natural Resources

The St. Paul District also has an informal agreement with the MDNR regarding maximum releases from the dams in relation to pool levels. Information on these guidelines can be found in the 1963 (revised in 1968) Master Regulation Manual with the exception of Pokegama, which does not have a guideline (See Table 3, Row 10).

Inundation of Knutson Dam

Cass Lake, above Knutson Dam, can be inundated by water levels behind Winnibigoshish Dam. The Corps owns flowage rights on the Cass Lake chain of lakes (see below).

Winnibigoshish, Fish Spawning, MDNR

This guideline represents an informal agreement with the Minnesota Department of Natural Resources. When runoff conditions in the spring permit, Winnibigoshish reservoir is regulated to enhance walleye spawning. A difference in the water level between Lake Winnibigoshish and Little Cut Foot Sioux Lake creates a current, which induces a spawning run into Little Cut Foot. The target is a reservoir level of between elevation 1297.44 and 1297.75 feet by approximately April 25. An elevation of 1297.75 feet during the period 18 to 25 April is optimal as it coincides with the top of the walleye egg-stripping boards that are placed at the inlet to Little Cut Foot Sioux bay by the Minnesota Department of Natural Resources. Between 25 April and the first day of the fishing season (approximately mid-May), the lake is gradually raised to the Normal Summer Band (1297.94 to 1298.44 feet). Spring runoff conditions do not allow this plan to be implemented every year. This guideline was adopted after the 1963 (revised in 1968) Master Water Control Manual was published (see Table 3, Row 8).

Cross Lake/Pine, Fish Spawning, MDNR

This guideline represents an informal agreement with the Minnesota Department of Natural Resources. In past years (prior to 2002), the beginning of Cross Lake's drawdown has been delayed to as late as December 15. The start of the drawdown was delayed in the fall, relative to the other Headwaters reservoirs, to promote whitefish spawning. The whitefish are dependent on cool water temperatures, as well as an adequate depth of water, for successful spawning.

The MDNR has recently recommended a change. Beginning in the fall of 2003, the drawdown will start on or about October 1. The process is currently being evaluated to determine whether or not the earlier start to the drawdown might be better overall (see Table 3, Row 8).

Reservoir Flowage Rights

The values listed in Table 2, Row 9 are for general use only. In many cases, an exact elevation cannot be assigned to the flowage rights as rights were obtained on: entire 40-acre parcels; by condemnation of entire strips of land; and by other means. In some cases, the records are simply not clear on the subject, or subsequent erosion has created problems. Flowage rights for the Cass Lake chain of lakes (upstream of Knutson Dam) are approximately 1 foot above the flowage rights on Winnibigoshish. Lake Winnibigoshish inundates Knutson Dam when the reservoir exceeds approximately elevation 1301.5 feet. The Corps also has flowage rights between Winnibigoshish/Leech and Pokegama as well as in other areas of the Headwaters.

Channel Capacity

The values listed in Table 2, Row 10 are the approximate non-damaging discharge in the river reach below the dam. These values can vary greatly depending

on the situation during a particular flood due to backwater effects, floating bog, weed growth, ice conditions, and other factors.

Rate-of-Release Guidelines, Minnesota Dept. of Natural Resources

The Corps has its own guidelines as well as agreements with the Minnesota Department of Natural Resources regarding rate-of-release changes.

Routine Rate-of-Release Rule

This regulation can be found in the 1963 (revised in 1968) Master Water Control Manual. It states: “Reductions or increases in discharge from [the] reservoirs are restricted insofar as practicable to changes in stage of not more than 6 inches per day in the discharge channels.”

Low-Flow Rate-of-Release Rule

In addition, the District is a formal signatory to the Mississippi River Low-Flow Management Plan which indicates no more than a 10 percent change in outflow at Winnibigoshish and Pokegama in any 2-hour period when the U.S. Geological Survey gage at Grand Rapids reports an average daily flow of 400 cfs or less.

In all cases, a large percent increase or decrease in the total magnitude of the flow is not advisable (e.g., going from 300 to 100 cfs or 2,000 to 1,000 cfs in one gate move). The District’s Environmental Resources Section is consulted when changes are being made during critical flow periods, particularly during low-flow conditions. Two or three gate changes per day are often necessary during critical flow periods to alleviate stress to fish and wildlife resources.

SOCIOECONOMIC RESOURCES

Introduction

The Mississippi River drains 33 States, and its watershed covers one-half of the Nation. It fosters cities and commerce; transports people and goods; provides habitat for fish, plants, and wildlife; and enriches human life with natural and recreational opportunities.

The Mississippi River's first basin is called the Upper Mississippi River Basin, and it covers approximately 20,100 square miles (12,864,000 acres) of the State of Minnesota. The basin includes the major population centers of the State including the Cities of Minneapolis and St. Paul. Additionally, some of the fastest growing areas within the State are included in the Upper Mississippi River Basin. Major cities in the basin include Minneapolis, St. Paul, Anoka, Chaska, Glencoe, Willmar, Litchfield, Buffalo, Cambridge, Elk River, St. Cloud, Foley, Milaca, Little Falls, Long Prairie, Alexandria, Brainerd, Aitkin, Park Rapids, Walker, Grand Rapids, and Bemidji.

Included in the Upper Mississippi River Basin are some of the major lakes-vacation areas of the State of Minnesota including the Brainerd Lakes Area, the Park Rapids-Bemidji-Walker Lakes Area, and the Alexandria Lakes Area.

Population

Population Trends

The Upper Mississippi River Basin stretches through east-central and north-central Minnesota, encompassing all or portions of 30 counties containing more than 60 percent of the State's 4.9 million residents. Demographically, the area is representative of population and growth patterns throughout the State, containing metropolitan populations, growing urban/suburban populations, and some rural areas with declining populations. Table 4 shows the population change between 1970 and 2000.

Growth of the 30-county region over the 1990's has been slightly higher (13.5 percent) than the State average (12.4 percent). This is primarily due to the rapid growth in counties bordering the Twin Cities metropolitan area.

Sherburne County tops the basin in growth with a 53 percent increase between 1990 and 2000, followed by Carver County at 46 percent. This is compared with 12 percent for the State as a whole. Renville County was the only county in the basin to show a decrease in population for the 10-year period.

Forests and wetlands and some of the major lakes-vacation areas of the State of Minnesota including the following counties characterize the northern portion of the basin: Hubbard, Crow Wing, Cass, and Beltrami. This segment contains a significant number of seasonal homes.

Table 4
The Upper Mississippi River Basin
Population Change 1970-2000

County/Population	1970	1980	1990	2000	% change 1990-2000
Aitkin	11,403	13,404	12,425	15,301	23.1%
Becker	24,372	29,336	27,881	30,000	7.6%
Beltrami	26,373	30,982	34,384	39,650	15.3%
Cass	17,323	21,050	21,791	27,150	24.6%
Clearwater	8,013	8,791	8,309	8,423	1.4%
Crow Wing	34,826	41,722	44,249	55,099	24.5%
Douglas	22,910	27,839	28,674	32,821	14.5%
Hubbard	10,583	14,098	14,939	18,376	23.0%
Itasca	35,530	43,069	40,863	43,992	7.7%
Otter Tail	46,097	51,937	50,714	57,159	12.7%
Pine	16,821	19,871	21,264	26,530	24.8%
Todd	22,114	24,991	23,363	24,426	4.5%
Wadena	12,412	14,192	13,154	13,713	4.2%
Benton	20,841	25,187	30,185	34,226	13.4%
Morrison	26,949	29,311	29,604	31,712	7.1%
Pope	11,107	11,657	10,745	11,236	4.6%
Sherburne	18,344	29,908	41,945	64,417	53.6%
Stearns	95,400	108,161	118,791	133,166	11.6%
Carver	28,331	37,046	47,915	70,205	46.5%
Kandiyohi	30,548	36,763	38,761	41,203	6.3%
McLeod	27,662	29,657	32,030	34,898	9.0%
Meeker	18,387	20,594	20,846	22,644	8.6%
Renville	21,139	20,401	17,673	17,154	-2.9%
Wright	38,933	58,681	68,710	89,986	31.0%
Mille Lacs	15,703	18,430	18,670	22,330	19.6%
Isanti	16,560	23,600	25,921	31,287	20.7%
Anoka	154,712	195,998	243,641	298,084	22.3%
Hennepin	960,080	941,411	1,032,431	1,116,200	8.1%
Ramsey	476,255	459,784	485,765	511,035	5.2%
Washington	83,003	113,571	145,896	201,130	37.9%
State of Minnesota				4,919,479	12.4%

Population Projections

Table 5 displays the Minnesota county population projection figures for the period 2000-2030. These projections were developed by the Minnesota State Demographic Center.

Table 5
The Upper Mississippi River Basin
Population Projections 2000-2030

County/Population	2000	2010	2020	2030	% change 2000-2030
Aitkin	15,301	18,570	22,160	25,270	65%
Becker	30,000	32,690	35,390	37,190	24%
Beltrami	39,650	45,040	49,920	54,450	37%
Cass	27,150	33,630	40,070	45,280	67%
Clearwater	8,423	8,810	9,210	9,500	13%
Crow Wing	55,099	67,090	79,420	90,240	64%
Douglas	32,821	36,970	41,720	46,180	41%
Hubbard	18,376	21,950	25,550	28,950	56%
Itasca	43,992	47,590	51,030	53,520	22%
Otter Tail	57,159	63,240	70,890	78,250	37%
Pine	26,530	30,360	34,380	37,840	43%
Todd	24,426	25,620	27,070	28,000	15%
Wadena	13,713	14,490	15,230	15,900	16%
Benton	34,226	39,010	42,600	44,960	31%
Morrison	31,712	33,550	35,590	37,190	17%
Pope	11,236	11,540	12,120	12,660	13%
Sherburne	64,417	86,350	105,630	121,920	89%
Stearns	133,166	148,450	163,200	177,370	33%
Carver	70,205	92,250	112,480	130,140	85%
Kandiyohi	41,203	43,670	45,980	47,680	16%
McLeod	34,898	37,490	39,780	41,580	19%
Meeker	22,644	24,520	26,470	27,890	23%
Renville	17,154	17,020	17,280	17,520	2%
Wright	89,986	109,710	126,410	139,010	54%
Mille Lacs	22,330	26,180	30,320	34,160	53%
Isanti	31,287	35,930	39,690	42,350	35%
Anoka	298,084	345,090	378,940	401,000	35%
Hennepin	1,116,200	1,199,740	1,259,880	1,298,480	16%
Ramsey	511,035	537,630	555,220	566,860	11%
Washington	201,130	251,500	294,690	332,190	65%
Minnesota	4,919,479	5,452,500	5,909,400	6,268,200	27%

Minnesota's population is projected to grow to 5.45 million by 2010 and to 6.27 million by 2030. The current population is about 5 million.

Gains are expected to be greatest in the Rochester-Twin Cities-St. Cloud corridor, but many rural areas can anticipate growth as well, especially if they have lakes and forests. Scott, Sherburne and Carver Counties are projected to be the fastest-growing in the decade, while 21 counties, mostly in western Minnesota, are expected to lose population.

The projections show the population will be older, due largely to continued aging of the baby boom generation. The number of Minnesotans ages 50 to 64 is expected to

grow by more than 300,000 between 2000 and 2010. Younger age groups are expected to grow more modestly. The number of children under age 15 is projected to grow about 10,000, for instance, while the number of 15- to 24-year-olds is expected to rise by about 62,000.

Sherburne County tops the basin in projected growth with an 89 percent increase between 2000 and 2030 followed by Carver County at 85 percent. This is compared with 27 percent for the State as a whole.

Income

Median Family Income

Median family income is the mid-point at which one-half of the families earn more and one-half earn less. According to 2000 census figures (1999 data), Washington County tops the basin in median family income with $74,576, compared to $56,874 for the State of Minnesota and $50,046 for the United States. Aitkin County has the lowest median family income in the basin with $37,290.

Table 6 displays median family income for years 1979, 1989, and 1999 and is based on U.S. Census data.

Table 6
The Upper Mississippi River Basin
Median Family Income

County	1979	1989	1999	% change 1989-1999
Aitkin	12,536	21,263	37,290	75.4%
Becker	15,080	24,994	41,807	67.3%
Beltrami	14,764	25,133	40,345	60.5%
Cass	12,684	22,022	40,156	82.3%
Clearwater	12,482	21,572	39,698	84.0%
Crow Wing	15,569	27,274	44,847	64.4%
Douglas	15,900	26,886	46,250	72.0%
Hubbard	13,388	24,127	41,177	70.7%
Itasca	18,661	27,252	44,025	61.5%
Otter Tail	15,204	26,805	42,740	59.4%
Pine	15,029	26,131	44,058	68.6%
Todd	13,329	23,462	39,920	70.1%
Wadena	13,533	22,872	38,618	68.8%
Benton	17,877	31,942	51,277	60.5%
Morrison	14,150	26,784	44,175	64.9%
Pope	14,424	24,177	42,818	77.1%
Sherburne	21,189	39,261	61,790	57.4%
Stearns	18,599	32,949	51,553	56.5%
Carver	23,112	43,554	73,577	68.9%
Kandiyohi	17,352	30,629	48,016	56.8%
McLeod	19,674	35,033	55,003	57.0%
Meeker	16,606	29,210	47,923	64.1%
Renville	17,198	28,109	45,065	60.3%
Wright	20,687	36,981	60,940	64.8%
Mille Lacs	15,790	27,170	44,054	62.1%
Isanti	19,382	35,154	55,996	59.3%
Anoka	24,885	42,931	64,261	49.7%
Hennepin	25,133	44,189	65,985	60.2%
Ramsey	23,267	39,926	57,747	44.6%
Washington	26,059	48,098	74,576	54.4%
State of Minnesota	21,185	36,916	56,874	54.1%
USA			50,046	

Per Capita Income

Per capita income is population based, representing total income divided by population to derive a per person income estimate. According to 2000 census figures (1999 data), Hennepin County tops the basin in per capita income with $28,789 compared to $23,198 for the State of Minnesota and $21,587 for the United States. Wadena County has the lowest per capita income in the basin with $15,146.

Table 7 displays per capita income for 1999.

Persons Below Poverty

Families and persons are classified as below poverty if their total family income or unrelated individual income was less than the poverty threshold specified for the applicable family size, age of householder, and number of children under 18 present. The Census Bureau uses the Federal Government's official poverty definition.

For example, the poverty threshold in 1999 for a family of four with two children less than 18 years of age was $16,895.

If the total income of a person's family is less than the threshold appropriate for that family, then the person is considered poor, together with every member of his of her family. If a person is not living with anyone related by birth, marriage, or adoption, then the person's own income is compared with his or her poverty threshold.

The poverty thresholds are updated every year to reflect changes in the Consumer Price Index. The poverty thresholds are the same for all parts of the country – they are not adjusted for regional, State, or local variations in the cost of living.

According to 2000 census figures (1999 data), Beltrami County has the highest number of people in the basin classified as below poverty with 17.6 percent, compared to 7.9 percent for the State of Minnesota and 12.4 percent for the United States. Washington County has the fewest number of people classified as below poverty with 2.9 percent.

Table 7 displays persons below poverty as a percentage for 1999.

Table 7
The Upper Mississippi River Basin
1999

County	Per Capita Money Income	Persons Below Poverty, Percent
Aitkin	17,848	11.6%
Becker	17,085	12.2%
Beltrami	15,497	17.6%
Cass	17,189	13.6%
Clearwater	15,694	15.1%
Crow Wing	19,174	9.8%
Douglas	18,850	8.5%
Hubbard	18,115	9.7%
Itasca	17,717	10.6%
Otter Tail	18,014	10.1%
Pine	17,445	11.3%
Todd	15,658	12.9%
Wadena	15,146	14.1%
Benton	19,008	7.1%
Morrison	16,566	11.1%
Pope	19,032	8.8%
Sherburne	21,322	4.4%
Stearns	19,211	8.7%
Carver	28,486	3.5%
Kandiyohi	19,627	9.2%
McLeod	20,137	4.8%
Meeker	18,628	7.1%
Renville	17,770	8.8%
Wright	21,844	4.7%
Mille Lacs	17,656	9.6%
Isanti	20,348	5.7%
Anoka	23,297	4.2%
Hennepin	28,789	8.3%
Ramsey	23,536	10.6%
Washington	28,148	2.9%
State of Minnesota	23,198	7.9%
USA	21,587	12.4%

Education

Among persons 25 years and over, 94.0 percent of Washington County's population has achieved high school or higher educational attainment. This is the county with the highest percentage in the basin and compares to 87.9 percent for the State of Minnesota, and 80.4 percent for the United States. Clearwater County has the lowest at 76.4 percent.

In Hennepin County, about 39.1 percent of the adults over 25 years of age possess bachelor's degrees or higher, compared with 27.4 percent for the State of Minnesota, and 24.4 percent for the United States. Todd County has the lowest at 10.0 percent.

The Upper Mississippi River Basin is home to many universities, State universities, private liberal arts colleges, community colleges, and technical and business colleges. The University of Minnesota, located in Minneapolis, is one of the most comprehensive public universities in the United States and ranks among the most prestigious. State universities are also located in St. Cloud and Bemidji.

Table 8 displays educational attainment among persons over 25 for the 30-county Upper Mississippi River Basin.

Table 8
The Upper Mississippi River Basin
Educational Attainment
Census 2000

County	High School Graduate	Bachelor's Degree
Aitkin	80.4%	11.3%
Becker	82.9%	16.7%
Beltrami	83.4%	23.5%
Cass	83.9%	16.6%
Clearwater	76.4%	14.7%
Crow Wing	86.3%	18.4%
Douglas	85.6%	17.3%
Hubbard	86.1%	20.2%
Itasca	85.6%	17.6%
Otter Tail	81.4%	17.2%
Pine	79.0%	10.3%
Todd	79.3%	10.0%
Wadena	79.5%	13.4%
Benton	84.9%	17.2%
Morrison	79.7%	12.6%
Pope	81.8%	14.7%
Sherburne	89.9%	19.4%
Stearns	86.2%	22.0%
Carver	91.4%	34.3%
Kandiyohi	83.5%	18.3%
McLeod	84.7%	15.4%
Meeker	81.5%	13.9%
Renville	80.9%	12.6%
Wright	88.1%	17.9%
Mille Lacs	81.3%	12.2%
Isanti	86.6%	14.5%
Anoka	91.0%	21.3%
Hennepin	90.6%	39.1%
Ramsey	87.6%	34.3%
Washington	94.0%	33.9%
State of Minnesota	87.9%	27.4%
USA	80.4%	24.4%

Employment

Table 9 shows occupation by type for residents over 16 years of age by county for the 30 counties that make up the Upper Mississippi River Basin.

Table 9
The Upper Mississippi River Basin
Employed Civilian Population 16 Years and Over, By Occupation
Census 2000

County	Management, professional, and related Occupations	Service Occupations	Sales and Office Occupations	Farming, fishing, and forestry Occupations	Construction, extraction, and maintenance Occupations	Production, transportation, and material moving Occupations
Aitkin	26.1%	19.2%	23.2%	1.7%	12.4%	17.4%
Becker	29.3%	16.8%	22.1%	2.3%	12.2%	17.4%
Beltrami	32.5%	18.9%	23.6%	1.6%	9.7%	13.7%
Cass	27.8%	18.3%	25.2%	1.6%	12.7%	14.5%
Clearwater	31.1%	17.5%	18.3%	3.5%	14.4%	15.2%
Crow Wing	29.4%	17.6%	26.3%	0.4%	10.8%	15.5%
Douglas	29.6%	14.8%	25.2%	1.1%	9.9%	19.5%
Hubbard	30.2%	16.0%	23.8%	1.9%	13.2%	14.9%
Itasca	26.2%	16.0%	24.5%	1.1%	12.9%	19.3%
Otter Tail	31.2%	15.6%	23.1%	2.3%	10.3%	17.5%
Pine	24.4%	22.5%	20.5%	1.7%	12.3%	18.6%
Todd	25.0%	14.8%	19.7%	3.4%	10.2%	26.8%
Wadena	29.3%	15.1%	21.2%	2.6%	10.2%	21.5%
Benton	25.8%	13.4%	27.3%	0.9%	10.6%	22.0%
Morrison	29.2%	14.3%	20.7%	2.4%	11.5%	21.8%
Pope	33.8%	15.5%	22.4%	3.0%	8.6%	16.6%
Sherburne	29.0%	12.6%	26.1%	0.5%	12.7%	19.2%
Stearns	30.2%	14.6%	26.6%	1.1%	8.8%	18.6%
Carver	40.7%	11.3%	26.6%	0.4%	7.9%	13.0%
Kandiyohi	30.8%	14.8%	24.7%	1.8%	9.3%	18.7%
McLeod	27.7%	11.9%	21.8%	1.2%	11.0%	26.4%
Meeker	27.6%	13.7%	21.4%	1.9%	10.1%	25.3%
Renville	30.9%	15.1%	19.8%	2.5%	9.3%	22.4%
Wright	29.2%	12.5%	26.1%	0.6%	12.5%	19.1%
Mille Lacs	24.1%	16.1%	22.7%	1.0%	11.4%	24.6%
Isanti	27.2%	12.9%	23.3%	0.8%	14.1%	21.7%
Anoka	32.2%	11.9%	28.3%	0.1%	10.4%	17.1%
Hennepin	42.5%	12.4%	28.6%	0.1%	5.6%	10.8%
Ramsey	39.9%	13.7%	27.3%	0.1%	6.3%	12.8%
Washington	41.0%	11.6%	28.2%	0.1%	7.8%	11.2%
Minnesota	35.8%	13.7%	26.5%	0.7%	8.4%	14.9%
USA	33.6%	14.9%	26.7%	0.7%	9.4%	14.6%

The University of Minnesota, with 34,300 employees, is Minneapolis's largest employer. Dayton Hudson follows with 22,600 employees and First Bank System with 14,725 employees.

The State of Minnesota, with 13,600 employees, is St. Paul's largest employer. St. Paul Public Schools follows with 6,500 employees and Health East Care System/St. Joseph's Hospital with 5,080 employees.

According to 2000 Census figures, Minnesota's civilian labor force totals 2,691,709, with an unemployment rate of 4.1 percent

Minnesota's 19 Fortune 500 firms represent a variety of industries, including but not limited to health care, banking, food processing, and industrial products. They are as follows with 2003 revenue (in billions): Target Corp. $48.1; United Health Group $28.8; Best Buy $22.6; SuperValu $19.1; 3M $18.2; US Bancorp $15.3; General Mills $10.5; Northwest Airlines $9.5; Cenex Harvest States $9.3; St. Paul Cos. $8.9; Xcel Energy $7.9; Medtronic $7.6; Thrivent Financial for Lutherans $6.5; Land O'Lakes $5.9; Hormel $4.2; Nash Finch $3.9; Ecolab $3.7; C.H. Robinson Worldwide $3.6; and Pepsi Americas $3.2.

Flood Damages

Winnibigoshish, Leech, Pokegama and Sandy reservoirs are regulated for flood control at Aitkin. Pokegama and Sandy are operated according to Spring and Summer Flood Control Guide Curves. The need for separate curves is necessitated by the additional rural damages that would take place during a summer flood as compared to an early spring flood. However, this flood control operation is accomplished with the assistance of Winnibigoshish and Leech (where the largest amount of storage resides).

The aforementioned Pokegama/Sandy/Aitkin Flood Control Guide Curves were developed from an analysis of historic flood events at Aitkin when the river exceeded a certain stage. The relationship is affected by the area distribution and time-volume relationships of individual floods. The curves show the relation between reservoir elevations and the corresponding peak flood stage at Aitkin, which will result, on the average, in the minimum total flood damages to affected interests in the three principal damage areas: Pokegama Lake; Sandy Lake; and the rural/urban Aitkin area. Potential damages are considered for residential, farm, commercial, industrial, and public properties/structures. Also factored in are the acres flooded and the damage per acre based on the various probable flood events and the time of year of occurrence.

The Aitkin diversion channel, completed in 1957, consists of a diversion channel about 6 miles in length bypassing Aitkin to help alleviate flood conditions. The channel is capable of carrying approximately 6,000 cubic feet per second, which is about 50 percent of a 16-year frequency flood with a maximum velocity of 2.5 feet per second. The operations of the Headwaters reservoirs have prevented an estimated $22 million in agricultural, residential, commercial, and industrial damages in the rural and urban Aitkin area. In addition, the Aitkin diversion channel has prevented an additional $11 million in damages. The Corps of Engineers has initiated an evaluation of potential Federal interest associated with a flood control project in the Aitkin area.

A new inventory of structures that could possibly be affected by high water as a result of the operation of the Headwaters reservoirs has been undertaken as part of the ongoing ROPE study. The inventory also includes all of the structures located in the

floodplain in the urban and rural Aitkin area. This inventory will be used to reevaluate the current flood control operating procedures and to compare it with possible changes in operating procedures to minimize damages on an equitable system-wide basis.

Navigation

The original authorized purpose for the Corps dams was to increase Mississippi River discharges during low-flow periods to aid navigation between St. Paul, Minnesota, and Lake Pepin, near Lake City, Minnesota. However, the need for flow augmentation from the reservoirs was greatly reduced after completion of the Mississippi River 9-foot channel project (i.e., locks and dams). Since that time, flood control, recreation, hydropower, water supply, and enhanced fish and wildlife production have been added as authorized project purposes. Knutson Dam is operated by the U.S. Forest Service primarily to maintain lake levels for recreational navigation and environmental purposes.

The Upper Mississippi River Basin Navigation System consists of about 1,250 miles of navigable streams and plays a major role in the movement of bulk commodities to the Nation's manufacturing centers. The Mississippi River and the Illinois River are the major navigation arteries. The rivers and several thousand miles of smaller streams are also available for recreational navigation and water-based recreation.

Within the ROPE study area, the U.S. Army Corps of Engineers has constructed and operates the following locks and dams: Upper St. Anthony Falls, Lower St. Anthony Falls, and Lock and Dam No. 1, all located in the Twin Cities; and Lock and Dam No. 2 located in Hastings, Minnesota.

Commercial navigation provides the Twin Cities region and the Upper Midwest with a vital link from the Nation's agricultural heartland to domestic and international markets. It is an integral part of a larger intermodal system, including truck and rail transport. Its impact on the economy is local, regional, and national in scope. The terminals in the region are a focal point for shippers that serve a large part of the Upper Midwest. River terminals in the Twin Cities region handle 15 to 20 million tons of commodities annually. The river system provides transportation to and from the region, including:

- Grain and mill products shipped to processors throughout the Nation's heartland and export terminals at the mouth of the river near the Gulf of Mexico.
- Other major long-haul southbound shipments including coal, potassic fertilizer, scrap iron, and petroleum coke.
- Inbound shipments of coal, phosphatic and nitrogen fertilizer, salt, petroleum products, chemicals, cement, steel, and pipe.
- Large local movement of sand, gravel, and petroleum products.

Hydropower

Nine hydropower dams are affected by the operation of the six Corps Headwaters Dams (see Table 10). Two additional hydropower facilities downstream of the Corps dams are in the planning stages (at Coon Rapids and Upper St. Anthony Falls). Two dams (Stump Lake and Prairie) are not affected by the operation of the Corps dams; however, their operation has an impact on the system's water control plan.

Water is released from the six Corps reservoirs in the fall and winter in order to draw down the water levels to create room to store the spring runoff. The total combined drawdown flow from all six dams varies each year depending on the hydrologic conditions (inflows, snowpack, etc.). In a typical year, the combined increment of flow needed above the inflow to accomplish the drawdown is approximately 1,000 cfs. However, this value can vary from 500 cfs to approximately 2,000 cfs depending on when the drawdown is started versus the progression of the snowpack during the winter. These releases occur during what would, under natural conditions, be a low-flow period. The increase in flow provides an economic benefit to the hydropower dams through increased power generation. The U.S. Forest Service dam on Cass Lake (Knutson Dam, upstream of Winnibigoshish) also contributes to the downstream flow duration. Knutson Dam's drawdown flows all pass through Winnibigoshish Dam.

Under Section 10f of the Federal Power Act, an owner of a hydropower plant is required to reimburse upstream owners of dams/reservoirs for an equitable part of the benefits it receives from the flow duration above the natural condition. The act requires the Federal Energy Regulatory Commission (FERC) to determine the benefits received by downstream hydropower project owners who have an installed generating capacity of greater than 1.5 megawatts (MW). The charges assessed by FERC to the hydropower owners are called "Headwaters Benefits Assessments" and the money collected is returned to the U.S. Treasury.

Table 10. Hydropower dams.

Selected Hydropower Dams Upstream of Lock and Dam No. 2 Mississippi River Watershed (listed in downstream order)			
Dam Name and Location (1.)	**Dam Operator**	**MW Capacity**	**Notes**
1. Stump Lake Dam Bemidji, MN	Otter Tail Power Co.	0.8	Stump L. Dam is upstream of the all Corps' dams. Otter Tail Power is a partner in the Corps' ROPE study.
2. Blandin Dam Grand Rapids, MN	Minnesota Power Co.	2.1	Affected by discharges from Winn, Leech and Pokegama Dam.
3. Prairie River Dam NE of Grand Rapids, MN	Minnesota Power Co.	1.1	On the Prairie River. Not affected by Corps dam operations.
4. Potlatch Dam Brainerd, MN	Missota Paper Co.	3.3	Affected by discharges from Winni, Leech, Pokegama, Sandy and Pine Dam.
5, Little Falls Dam Little Falls, MN	Minnesota Power Co	4.9	Downstream of all the Corps Headwaters Dams.
6. Sylvan Dam SE of Pillager, MN	Minnesota Power Co	1.8	On the Crow Wing River. Affected by discharges from Gull Lake Dam.
7. Blanchard Dam Near Royalton, MN	Minnesota Power Co	18.0	Downstream of all the Corps Headwaters Dams.
8. Champion Dam Sartell, MN	Champion Intl. Paper Co.	9.5	Downstream of all the Corps Headwaters Dams.
9. St. Cloud Dam St. Cloud, MN	City of St. Cloud	8.8	Downstream of all the Corps Headwaters Dams.
10. Coon Rapids Dam Coon Rapids, MN	*Three Rivers Park Dist.*	*NA*	*Reactivating hydropower in the dam is in the planning stages.*
11. Upper St. Anthony Falls Minneapolis, MN	XCEL Energy	12.0	Downstream of all the Corps Headwaters Dams.
12. Upper St. Anthony Falls Minneapolis, MN	*Crown Hydropower*	*NA*	*Still in the planning stages.*
13. Lock and Dam No. 1	Ford Motor Co.	14.4	Downstream of all the Corps Headwaters dams.
1. All the dams are on the Mississippi River unless otherwise noted.			

Agriculture

In 1992, the State of Minnesota had 75,079 farms totaling 25,666,944 acres. The average farm size was 342 acres. In 2001, total cash receipts were over $9.5 billion.

The most fertile land in Minnesota is located to the south and east of the basin, although Kandiyohi, Meeker, and McLeod Counties, and part of Stearns County, have some excellent cropland. Corn, soybeans, hay, and wheat are the major crops. Stearns leads all counties with a total value of farm products of about $345 million. Renville County ranked second in total farm receipts and second in farm receipts from crops. Kandiyohi County ranked sixth in total farm receipts and fourth in farm receipts from livestock.

The changing pattern of the farm industry in the basin corresponds to that of the Nation in that the number of farms is decreasing and the average farm size is increasing, employing more capital and less labor.

Recreation

Historically, the lands and waters provided food and shelter for the Native Americans and early explorers in the region. As settlement advanced into the region, much of the forested land in Minnesota was cleared for agriculture and/or timber in the late 1800's and early 1900's. While the lands and waters still provided food, there was a shift in utilization from subsistence to supplemental, with the establishment of hunting and fishing camps. With the growth of recreation, the taking of game and fish, the harvesting wild rice, and the gathering of fruits, berries, and mushrooms have for many become a recreational experience. For Native Americans, these activities form an important part of their culture and heritage.

In the earlier years of the 20th century, before the widespread use of the automobile, taking vacations "up north" "at the lake" meant taking the train. Resort owners would meet the trains at various stations and take their guests to the resorts by wagon. As roads improved and the use of automobiles increased, families would buy lakeshore property and build cabins for use during the summer.

The recreational use and development of the region expanded greatly in the years following World War II. At the same time, other industries, such as farming and timber harvesting, were declining. As a result, the economy began to shift towards more dependence on summer residents and tourism. In Minnesota, water-oriented recreation has traditionally focused on lakes. During the middle of the 20th century, most of the resorts were small, "ma and pa" operations. They were very lake dependent, advertising fishing, boating, and swimming activities; basically, summer activities. Private development around the lakes increased, as it seemed everyone wanted a cabin by the lake to go to during the summer. With most of the activity occurring during the summer, many of the recreation-related/dependent businesses would close during the winter.

In the latter part of the century, the development of the snowmobile and the rediscovery of cross-country skiing and snowshoeing resulted in the development of trail networks and increasing winter recreational use of the region. Cabin and resort owners began to winterize so they could use their property year-round. Cabin owners began to think of their cabins as a retirement home. Cabins that were once used only during the summer were remodeled or replaced by year-round residences. Resorts began to cater to the winter recreation folks. Businesses began staying open year-round in response to the increasing recreational activity in the region.

Over the years, many of the smaller resorts closed, with some of the properties being sold for private developments. A number of the larger resorts have changed their focus from water-based recreation to multiple recreational opportunities combined with conference centers. A large number of golf courses have been developed in the region. Summer use of the trail systems by mountain bikers and all-terrain vehicle (ATV) riders also is increasing. Hunting and fishing activities within the region have remained

relatively stable and still account for a sizable portion of the overall recreational use of the area.

The increased economic activity and number of year-round residences have attracted new business, primarily service and retail sales, into the region. These, in turn, have attracted people to live and work in the region. Improved highways have increased accessibility to and within the region for those seeking the recreational opportunities offered. The result is an increasing demand on the recreational resources, primarily the lakes in the region.

NATURAL RESOURCES

Aquatic Habitat

Table 11 shows some important statistics for the aquatic habitat of the eight primary study lakes. In general, the aquatic habitat of the Headwaters of the Upper Mississippi River (HUMR) is of good quality, but increasing pressure from development and recreation could lead to a decrease in habitat quality. Possible factors that may contribute to this include increased erosion and sedimentation. In general, the lakes have good aquatic plant communities, which act as a base for other forms of aquatic life. There is concern, though, that vegetation is declining due to the impacts of shoreline development. People often clear aquatic vegetation for boat docks and swimming areas. Over time, this loss could lead to a decrease in the suitability of fish spawning and nursery habitat.

Table 11. Characteristics of primary study lakes.

Lake Name	*Area (acres)*	*Littoral Area (acres)*	*Maximum Depth (ft)*
Bemidji	6,420	1,862	76
Cass	15,596	3,119	120
Winnibigoshish	58,544	18,904	70
Leech	111,527	57,994	150
Pokegama	6,612	1,978	112
Big Sandy	6,526	3,067	84
Cross/Whitefish	7,370	2,713	138
Gull	9,418	2,825	80

The project area also contains many miles of riverine aquatic habitat. Table 12 lists the primary study rivers and the length of river in the study area.

Table 12. Potentially affected rivers in the study area.

River	*River Miles*
Leech Lake River	24
Sandy River	1
Pine River	28
Gull River	19
Mississippi River from Bemidji to Brainerd	292
Mississippi River from Brainerd to St. Croix River	186

Wetland/Floodplain Habitat

The Upper Mississippi River above Lock and Dam 2 is about 21 percent wetland. The Upper Mississippi River is bordered by floodplain wetlands in much of the Headwaters region. Floodplain wetlands along the river have been greatly affected by reservoir regulation and river channelization. However, these wetlands are still highly valuable. The area between Leech Lake, Lake Winnibigoshish, and Pokegama Lake is a large and relatively high-quality wetland area. Many of the reservoirs are also fringed with wetlands. Much of the shorelines of Leech Lake and Lake Winnibigoshish are undefined and merge into large wetland areas. Also, there is an extensive wetland area east of Leech Lake and Lake Winnibigoshish between the Mississippi and Leech Lake Rivers (see Plate 2). These wetlands are influenced greatly by lake water levels and would be affected by changes in reservoir operation.

Wild rice is a key wetland plant species that can be found throughout the HUMR. Wild rice is used by humans and a number of waterfowl species as a food source. Wild rice requires rather specific water level conditions to prosper. It is considered an important resource in most areas upstream of Little Falls and is particularly important at Big Sandy, Leech Lake, Lake Winnibigoshish, and numerous smaller lakes.

Terrestrial/Upland Habitat

Terrestrial or upland habitat of the drainage of the HUMR is characterized as 4% developed, 28% forested, 20% cropland, and 17% pasture/hay. Forested areas contain tree species such as sugar maple and basswood in the southern and western areas, and white spruce, balsam fir, and paper birch in the northeastern areas. The composition of individual forests is largely dependent on soil, as pines prefer lighter soils whereas hardwood species prefer heavier soils. Cropland is typically planted to row crops such as corn, but small grains can also be found.

Fish

The lakes and rivers of the HUMR generally have healthy fisheries. Walleye, northern pike, muskellunge, yellow perch, largemouth bass, smallmouth bass, bluegill, and crappie are the most common species sought after by anglers. Walleye tend to be the most important game fish for most anglers. Some lakes are stocked with game fish species by the MDNR, but many are supported strictly by natural reproduction. In

general, game fish populations are stable; however, increased fishing pressure has led to decreased individual fishing success. In some cases, this has led to the perception that the fishery is in decline. While in general fish populations are stable, the potential for future problems is increasing due to increasing human impacts.

Other common fish species that can be found in some or all areas of the HUMR include rock bass, pumpkinseed sunfish, sauger, whitefish, tullibee (cicso), shorthead redhorse, bullheads, white sucker, burbot (eelpout), bowfin (dogfish), common carp, common shiner, and rainbow smelt.

A number of fish species are less common in the HUMR, and some are listed as species of special concern by the MDNR. The lake sturgeon, least darter, and pugnose shiner are three species found in the study area that are listed as species of special concern by the MDNR. The American eel, longear sunfish, greater redhorse, and weed shiner are four species being considered for listing by the MDNR. Impacts to these and other non-game fish species will be considered during the ROPE study. No federally listed threatened or endangered fish species are known to occur in the HUMR.

Mussels

Historically, as many as 39 mussel species including three federally listed species – Higgins eye mussel (*Lampsilis higginsii*), winged mapleleaf *(Quadrula fragosa),* and fat pocketbook *(Potamilus capax)* – and most state listed species in Minnesota have been found within the Mississippi River Headwaters study basin. The mussel fauna below the Falls of St. Anthony was historically and presently is far more diverse than the fauna above the Falls, a result of the Falls itself, which historically served as a faunal barrier to the post-glacial upstream migration of mussels. Nineteen of the 39 species either occurred historically or are present below the Falls of St. Anthony and exclusive to Pools 1 and 2 including several Minnesota state listed species and the three federally endangered species. No naturally occurring populations of the three federally endangered species currently exist in the Mississippi River Headwaters study basin.

Presently, 21 live species occur in Pools 1 and 2 with an additional 15 historical species. Individuals from seven of these 15 historical species occurring below the Falls have been relocated from lower Mississippi River pools during 2000-01 to areas in Pool 2, including 371 of the federally endangered *L. higginsii*. The mussel fauna within Pools 1 and 2 is dominated (in descending order) by three-horned wartyback (*Obliquaria reflexa*), threeridge (*Amblema plicata*), deertoe (*Truncilla truncata*), and mapleleaf (*Quadrula quadrula*). At least five state listed species are present, including two listed as endangered in Minnesota, rock pocketbook (*Arcidens confragosus)* and wartyback (*Quadrula nodulata). Quadrula nodulata* ranked fourth in abundance in Pools 1 and 2, and nowhere in the Upper Midwest has the species been reported in such high numbers.

It appears that mussels are expanding their range above St. Anthony Falls, now easily circumnavigated by mussels' obligatory host fish through the navigation locks. The Mississippi River St. Anthony Falls Pool (St. Anthony Falls to the Coon Rapids Dam) harbors 17 live species including 11 species previously not reported. Apparently, these species have arrived as larvae attached to fish that have used navigation locks to travel around the Falls of St. Anthony. The community is dominated by deertoe with three other species also abundant: mapleleaf, plain pocketbook (*L. cardium*), and pink heelsplitter (*Potamilus alatus*). Two Minnesota state listed species also occur: black sandshell (*Ligumia recta*) (special concern) and round pigtoe (*Pleurobema sintoxia*) (threatened).

It appears at present that the Coon Rapids Dam serves as a faunal barrier to upstream dispersal from the lower Mississippi River, much as the Falls of St. Anthony has done historically. The entire Mississippi River proper above the Coon Rapids Dam harbors only 11 live species and, cumulatively, the Mississippi River tributaries above the Coon Rapids Dam harbor the same 11 species plus an additional one, threeridge (*Amblema plicata)*. In addition to being less species rich, mussel community composition and species' relative abundance vary as well, as compared to the lower river. Generally, in riverine portions of these upper reaches of the Mississippi River and its tributaries, communities tend to be dominated by fatmucket (*Lampsilis siliquoidea*) and plain pocketbook, whereas in lakes and reservoirs, giant floater (*Pyganodon grandis*), a species more adapted to softer substrate and lentic conditions, tends to be dominant. Not surprisingly, two species present in these upper reaches and not found in the Mississippi River proper below the Coon Rapids Dam, creek heelsplitter (*Lasmigona compressa*) and paper pondshell (*Anodontoides ferussacianus*), are more typical of headwaters and smaller streams. Creek heelsplitter is generally found throughout these upper reaches, and although found in the Mississippi River proper, they tend to be more common in the smaller tributary streams. Cylindrical papershell (*Anodontoides ferussacianus)* typically occurs in small order tributary streams and the extreme Headwaters of the Mississippi River. Two state listed species present are the black sandshell and creek heelsplitter. Black sandshell populations appear healthy in many areas of the riverine portions of the Mississippi River.

Most mussels are adapted to riverine habitat with a few minor exceptions. Mussels that have adapted to lentic habitats or do survive in reservoirs typically reside in shallow areas where oxygen is available and wave action maintains a more consolidated silt-free substrate. The construction and operation of the Headwater dams no doubt had an initial impact on mussels. As natural reservoirs were enlarged, relatively non-motile mussels would have been further inundated by water, effectively distributing them in deeper water and exposing them to anoxic conditions and flocculent-laden substrate. The dewatering and the altered flow regime affected mussels immediately downstream of dams by the operation of the dams. Dams have impeded fish host passage, possibly isolating mussel populations from their obligate host fish and/or limiting the potential for mussel dispersal.

Zebra mussels have invaded the Great Lakes and the Mississippi River basin and recently have been discovered in Lake Ossawinnamakee near Cross Lake, which is drained by Pelican Brook, a tributary of the Mississippi River near Pine River. This species colonizes native mussels and impedes their movement, reduces their ability to feed and eliminate wastes, and competes for food and space, which often results in significant native mussel mortality. Zebra mussels are a lentic species that thrive in the lower pools of the Upper Mississippi River, the St. Louis River estuary, and many other reservoirs and lakes in midwestern and eastern North America. During the larval stage, zebra mussels are free floating and subject to dispersal by currents. It remains speculative as to the origin of the recent invasion in Headwaters drainage, but they are easily transported by live wells, bait buckets, etc. They tend to not survive in great numbers in lotic conditions, so the maintenance of the Headwater reservoirs may provide ideal zebra mussel habitat.

Birds

Approximately 240 species of birds can be found in the HUMR. It would be impractical to discuss even a large portion of those species here. Furthermore, the significance of the occurrence of bird species is variable depending on a number of factors. Some species migrate through the area and are present for only short periods of time, breeding and over-wintering north and south of the HUMR, respectively. Other species are summer residents that use the region only for reproduction. Still others are yearly residents that use the region to carry out their entire life cycles. Likely even more important than these factors for purposes here is the type of habitat used by a species while in the region. A resident common crow, while present year-round, would not be affected by changes in aquatic environments. On the other hand, a migrating shorebird, present in the region for only a few weeks during migration, could not complete its migration and life cycle if high water inundated feeding and resting habitat.

Some groups of birds are more likely to be affected by water level management than others. Surface-feeding ducks such as mallards and wood ducks depend on emergent and submersed vegetation for food and cover. Bay ducks, such as lesser scaup, depend on submersed vegetation and invertebrates for food. Marsh birds, such as yellow rail, depend on emergent vegetation for shelter and the invertebrates living there for food. Shorebirds such as spotted sandpiper require bare open areas such as mud flats for feeding. The common tern nests on Leech Lake and is listed as a threatened species by the MDNR. The common loon is found throughout the northern portion of the study area and nests on the water's edge, thus making it vulnerable to water level changes.

Mammals

Many species of mammals inhabit the HUMR; however, only those that prefer wet lowland areas or those dependent on aquatic systems and would possibly be affected by the outcome of the ROPE study are discussed here. Other species would

possibly be affected indirectly; however, drawing conclusions as to the relative magnitude of effects would be difficult or impossible for the scope of this study.

Lowland mammals, or those that can be found near or seem to prefer wet areas, found in the HUMR include arctic shrew, pygmy shrew, southern bog lemming, meadow vole, red-backed vole, meadow jumping mouse, woodland jumping mouse, raccoon, least weasel, long-tailed weasel, and white-tailed deer. These mammals are not necessarily dependent on wetland habitats and would likely be indirectly affected by the ROPE study outcomes. There is no evidence that the populations of these lowland mammals are in decline with the exception of the least weasel, which is listed as a species of special concern by the MDNR.

Aquatic species found in the HUMR include water shrew, star-nosed mole, beaver, muskrat, mink, otter, and moose. These mammal species, with the possible exception of the moose, require access to open water as a source of food and in some cases as a source of shelter. Water-level management can have a major impact on aquatic mammals by inundating or exposing their shelters at times of the year when the animals are vulnerable to the elements or predators. Also, water-level management can influence the vegetation, which is needed for food and shelter. There is no evidence that populations of these aquatic mammals are in decline; in fact, the otter has made an excellent recovery since the turn of the 20th century.

Threatened and Endangered Species

Three species found in the HUMR are on the Federal threatened and endangered species list. The Canada lynx is listed as a threatened species and may be found in the far northern portion of the study area. They prefer dense forests and prey on showshoe hares. Lynx populations cycle with showshoe hare populations, and at times when showshoe hare numbers are low, it is likely that there are no lynx in Minnesota. The gray wolf, also listed as a threatened species, can be found throughout the northern half of the study area. There are about 2,500 gray wolves in Minnesota. They prefer forested areas and prey on deer, moose, beavers, and small mammals. The bald eagle is listed as threatened and is found throughout the project area. They feed primarily on fish and, therefore, are usually found near water. Eagle numbers have been steadily increasing since a ban on DDT was enacted in 1974.

Potential project effects on these species will be studied further and coordinated with the U.S. Fish and Wildlife Service in accordance with Section 7 of the Endangered Species Act.

Biological Productivity

Biological productivity is basically the quantity of living organisms a habitat can support. High biological productivity is good in cases where desirable species are in abundance, but is bad in cases where undesirable species replace desirable ones. In general, biological productivity in the study area is good. However, numbers of the

common game species are lower than desired in some areas. To help alleviate this, some species of fish such as walleye and musky are stocked in an effort to increase their numbers. Also, projects to improve waterfowl habitat are often implemented. In conjunction with methods to increase numbers, game regulations are set to limit harvest. This helps ensure that harvest does not exceed production.

However, biological productivity is too high in some lakes where excessive nutrient inputs result in algal blooms. Many lakes in the study area are oligotrophic (see water quality section below), and low biological productivity is desirable. An increase in primary production causes shifts in a lake's aquatic ecosystem that often result in increases in undesirable species and decreases in water clarity. Decreases in submersed vegetation can also result. Water level management may provide a means to alleviate some of the symptoms of excessive nutrient inputs, but solving the problem requires a broader watershed-scale approach.

Biological Diversity

Biological diversity is the variety of living organisms, their habitats, and the processes occurring there. In general, biodiversity is declining in freshwater environments all over the world. The numerous aquatic species on the threatened and endangered species list in the United States is evidence of this. Some of the known causes are pollution, sedimentation, nutrient runoff, and the introduction of exotic species. Another known cause is an unnatural hydrologic cycle. This factor is directly related to potential outcomes of the ROPE study.

While it is not possible to know the magnitude to which biological diversity in the HUMR has decreased since European settlement, it is likely that there has been a decline. It is possible to argue that biological diversity in the HUMR could have increased in certain habitats since European settlement. However, it is unknown as to whether or not this has been shown in the HUMR. Also, in instances where this has been found, often the increase in biological diversity can be attributed to the expansion of higher numbers of more tolerant, less desirable species into a habitat that had been dominated by fewer and often more desirable but less tolerant species. A common example of this is a former high-quality trout stream that after watershed impacts became warmer and more turbid, and consequently supported a more diverse warm-water fish community. At the stream-reach or even the watershed scale, this example would have a higher biological diversity. However, at a larger scale, the likely cumulative effect would be lower diversity due to a loss in sensitive cold-water species that were not replaced by new species but simply forced out by existing warm-water ones.

In the HUMR, changes in the hydrologic cycle subsequent to the construction and operation of the reservoir dams likely contributed to a decline in biological diversity. Since the late 1930's, the operation of the Headwaters has been marked by increasingly stable water levels and a shift in the timing of events. Changes in the timing of peak spring reservoir levels and river flows upset fish spawning, bird nesting, and furbearer

reproduction activities. Also, by holding water back in the spring, the river does not receive the high flows necessary for cleansing silt from the river bottom, which reduces habitat quality for benthic invertebrates. Furthermore, the winter drawdown, which lowers reservoir levels and raises river flows, can negatively affect whitefish spawning and winter habitat for aquatic mammals, turtles, frogs, and a variety of other lake and riverine organisms. These types of changes favor more adaptable species and can eliminate those that have more specific requirements.

Just as important as these effects, possibly more so, are changes in the vegetative community. Eliminating the larger periodic hydrologic events would have had a major influence on the aquatic vegetation. Under natural conditions, high water levels would have set back woody vegetation. High water levels would also have increased the extent of emergent vegetation, which is important to waterfowl, aquatic mammals, marsh birds, and some fish species. Low water levels, such as those that would occur during a drought, would increase the area over which emergent and submersed vegetation would grow, thereby increasing the amount of habitat available to fish and other aquatic species. Furthermore, natural variability in water levels would allow a wider variety of plant species to establish, and consequently animal species as well, thereby improving biological diversity.

Potentially Affected Significant Resources

The Environmental Task Force (ETF) is a group formed to provide technical environmental support to the ROPE. The ETF consists of professionals in environmental sciences from the Corps of Engineers, U.S. Forest Service, Minnesota Department of Natural Resources, and Minnesota Pollution Control Agency. The ETF was formed in 2002 and has met periodically since then to discuss ROPE issues.

One of the tasks completed by the ETF was the development of a list of natural resources that would potentially be affected by the ROPE. In most cases, these resources were chosen as representatives of groups of organisms that may be affected, because it would be difficult or impossible to list them all. Therefore, while this list may not be all-inclusive, the impacts to all resources should be represented by the key resources. Table 13 lists these resources and some key factors that influenced their inclusion.

During the development and evaluation of alternative operating plans within the ROPE, models will be developed to measure the potential impacts to these resources. The results from that modeling will be used to influence the selection of an alternative operating plan.

Table 13. Significant natural resources of the HUMR.

Resource	*Significance*	*Limiting Factor*	*Relationship to Operation*
Walleye	Sport fishing Ecological health	Spawning habitat	High stable lake levels increase sedimentation of spawning habitat.
Smallmouth Bass	Sport fishing Ecological health	Rearing habitat	Artificially high river levels decrease suitability of rearing habitat.
Whitefish	Ecological health Harvest	Spawning habitat	Winter drawdown disturbs spawning sites.
Greater Redhorse	Ecological health	Spawning habitat	Altered hydrology reduces spawning habitat suitability.
Musky	Sport fishing Ecological health	Nursery habitat	Decreased vegetation beds partially caused by altered hydrology.
Winter Aquatic Community	Ecological health	Over-wintering habitat	Unnaturally high flows during reservoir drawdown.
Summer Aquatic Community	Ecological health	Low flows and low dissolved oxygen	Low flows are determined by regulated discharge.
Submersed Aquatic Vegetation	Ecological health	Stable water levels	Potential to affect existing beds.
Emergent Vegetation	Ecological health	Stable water levels	Lack of low water levels prevents regeneration.
Undesirable Emergent Vegetation	Ecological health	Invading exposed mud flats	Potential to increase spread through improper management.
Wild Rice	Ecological health Harvest	Altered hydrology	Altered hydrology can limit production.
Sedge Meadows	Ecological health	Altered hydrology	Altered hydrology may be keeping meadows too dry.
Surface-Feeding Ducks (mallard)	Ecological health Hunting	Decline in migration and nesting habitat	Altered hydrology and effects to vegetation.
Bay Ducks (scaup)	Ecological health Hunting	Decline in food and migration habitat	Altered hydrology and effects to vegetation.
Marsh Birds	Ecological health	Decreasing amount of habitat – sedge meadows	Altered hydrology and effects to meadow habitat.
Shorebirds and Terns	Ecological health	Nesting habitat – exposed beaches	Decrease in exposed mud flats due to stable water levels.
Wetland Riparian Mammals (furbearers)	Ecological health Harvest	Breeding, denning, and rearing affected by altered hydrology	Altered hydrology; more specifically, the timing of high water events.

Water Quality

Effects of Dam Operations On Lake Water Quality

All of the Mississippi Headwaters dams affect water levels in numerous adjoining lakes whose water surface elevations are within the operating range of reservoir operations. It follows that, to whatever extent lake water quality may be related to dam operations, many of these lakes could be similarly affected. Presently, there are no data or site-specific studies in the region that can support general or specific conclusions. The mechanisms by which water quality changes could be caused include:

- Higher or lower summer pool affecting the size and placement of littoral and riparian communities. Changes in lake nutrition (inflow and cycling of nutrients) and localized dissolved oxygen conditions could happen but would likely be minor.
- Changing the vertical operating range or changing the mode of the annual operating cycle could affect the size and placement of littoral and riparian communities and could modify the volume and seasonal timing of water movement into and out of riparian wetlands. Such water exchange could be a significant factor in assessing potential methyl-mercury loading and bioaccumulation in fish.

Most of the adjoining lakes have been the subjects of Minnesota Pollution Control Agency (MPCA) lake assessments to classify the lakes' general trophic condition (i.e., Are they overnourished?), and to determine their status with respect to designated beneficial use objectives such as "swimming". Table 14 lists the lakes affected by the six Headwaters dams and describes their general water quality condition (data for Lake Bemidji and Cass Lake will be included at a later date). The designations "Oligotrophic", "Mesotrophic", and "Eutrophic" are determined from the Trophic State Index (TSI), which is based on measures of water transparency, total phosphorus, and summer chlorophyll. Use impairment (swimming) status is indicated by "FS" (fully supporting), "ST" (supporting but threatened), or "NS" (not supporting). Some of the lakes have had fish consumption advisories posted by the Minnesota Department of Health. Those without advisories may not yet have been tested.

The Clean Water Act requires States to publish, every 2 years, an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards and is organized by river basin. In Minnesota, the MPCA is tasked with compiling and updating this list. Summaries of some resulting information are presented below.

Two pollutants are of interest within the study area, mercury and PCB's. The MPCA lists these as bioaccumulative toxics, which means they accumulate in

organisms up the food chain. The MPCA has developed a map of the Headwaters basin (Figure 4) that shows impaired water bodies and the contaminant responsible for that listing. Most waters are listed as impaired for mercury and a few near the southern portion of the study area are listed for PCB's. Mercury is introduced to most aquatic habitats in the study area via atmospheric precipitation rather than through immediately adjacent industrial sources. The occurrence of mercury in its toxic methyl-mercury form is generally associated with low dissolved oxygen and low Eh (redox potential) water in wetlands. PCB's have been used extensively in industry and were typically introduced into aquatic habitats via point sources. Therefore, aquatic habitats listed as impaired for PCB's in the study area typically are found in more industrial settings.

The MPCA has also developed a map of the Headwaters basin (Figure 5) that shows waters impaired for aquatic life and/or aquatic restoration. The factor contributing to the impairment is also given for each impaired water. In the northern half of the study area, the typical factors listed for impairment are either turbidity or low dissolved oxygen. In the southern half of the study area, fecal coliform, biota, low dissolved oxygen, and turbidity are typical listed factors.

Changing the mode of the annual operating cycle could modify the volume and seasonal timing of water movement into and out of riparian wetlands. Such water exchange could be a significant factor in assessing potential methyl-mercury loading and bioaccumulation in fish. Scientific studies are needed to determine whether modifying the flow regime could improve fish habitat by eliminating stressful low dissolved oxygen conditions and reduce methyl-mercury loading.

Table 14. Water quality data for selected lakes and reservoirs.

Lakes	County	Transparency Secchi (ft.)	WQ Data (MPCA)	Trophic State Index	Trophic State	Swimming Use	Fish Advisory (mercury)
Affected by Winnibigoshish Dam							
Winnibigoshish	Cass	7.2	wq	49	M	FS	adv
Cutfoot Sioux	Itasca	3.6		60	E	NS	adv
Sunken	Itasca						
Little							
Brauswah							
Upper Pigeon	Itasca						
Middle pigeon	Itasca						
Lower Pigeon	Itasca						
Dixon	Itasca	4.6	wq	55	E	PS	
Little Dixon	Itasca						
Sioux	Itasca						
Kenogama	Itasca						
Raven	Itasca						
Rabbits	Itasca						
Sugar	Cass		wq				
Cass	Beltrami	12.8	wq	40	O	FS	adv
Rice (Little)	Beltrami						
Popple	Beltrami						
Little Wolf	Cass	8.2	wq	52	M	ST	adv
Wolf	Beltrami	11.5	wq	42	M	FS	adv
Mud	Hubbard						
Buck	Beltrami						
Kitchi	Beltrami						adv
Long	Beltrami	16.1		37	O	FS	
Big	Beltrami	11.5		42	M	FS	
Burns							
Moose	Beltrami	10.8		46	M	FS	
Andrusia	Beltrami	7.5	wq	57	E	PS	adv
Pike Bay	Cass	8.5	wq	48	M	FS	adv
Affected by Leech Lake Dam							
Leech	Cass	8.9		46	M	FS	adv.
Steamboat	Cass						
Little Steamboat							
Boy	Cass						
Portage	Cass	17.7		36	O	FS	
Lomish	Cass						
Swift	Cass						
Three							
Sucker	Cass						
Swamp	Cass						
Kebekona	Hubbard	11.5	wq	40	O		adv.
Benedict	Hubbard	12.5	wq	41	M	FS	
Horseshoe	Cass						

Table 14. (continued) Water quality data for selected lakes and reservoirs.

Lakes	County	Transparency Secchi (ft.)	WQ Data (MPCA)	Trophic State Index	Trophic State	Swimming Use	Fish Advisory (mercury)
Garfield	Hubbard	10.5	wq	43	M	FS	
Affected By Pokegama Dam							
Pokegama	Itasca	15.4		38	O	FS	adv
Ball Club	Itasca	9.8	wq	48	M	FS	adv
White Oak							
Little White Oak							
Rice		15.1		38	O	FS	
Little Rice							
Loon		13.1		40	O	FS	
Vermillion		4.3		54	E	FS	
Little Varmillion							
Gould							
Siseebakwet		13.8		39	O	FS	
Little Sissebakwet		3.3		54	E	PS	
Long		14.4		39	O	FS	
Snells							
Leighton							
Blackwater							
Cutoff							
Little Drum							
Affected by Sandy Lake Dam							
Sandy	Aitkin	4.6	wq	58	E	PS	
Aitkin	Aitkin						
Sandy River Flowage	Aitkin						
Davis	Aitkin	3		60	E	PS	
Round	Aitkin	15.1		38	O	FS	
Tiesen	Aitkin						
Sandy River	Aitkin						
Rat	Aitkin	5.2		53	E	ST	
Affected by Pine River Dam							
Cross	Crow Wing	13.5	wq	40	O	FS	
DaggettLittle Pine	Crow Wing	7.2	wq	49	M	FS	
Rush	Crow Wing	16.1	wq	38	O	FS	
Island	Crow Wing	6.2		51	E	ST	
Ox	Crow Wing						
Upper Whitefish	Crow Wing		wq				adv
Lower Whitefish	Crow Wing	13.8	wq	42	M	ST	adv
Big Trout	Crow Wing	16.7	wq	39	O	FS	
Arrowhead	Crow Wing						
Pig	Crow Wing	14.8		38	O	FS	
Clamshell	Crow Wing	17.1	wq	36	O	FS	
Bertha	Crow Wing	16.4	wq	37	O	FS	
Upper Hay	Crow Wing	15.1	wq	38	O	FS	

Table 14. (continued) Water quality data for selected lakes and reservoirs.

Lakes	County	Transparency Secchi (ft.)	WQ Data (MPCA)	Trophic State Index	Trophic State	Swimming Use	Fish Advisory (mercury)
Lower Hay	Crow Wing	13.1	wq	40	O	FS	
Affected by Gull Lake Dam							
Gull	Cass	8.5	wq	46	M	FS	adv
Upper Gull	Cass	9.2	wq	45	M	FS	
Roy	Crow Wing	9.5	wq	45	M	FS	
Nisswa	Crow Wing	9.5	wq	45	M	FS	
Round		10.5		48	M	FS	
Spider	Cass	10.2	wq	44	M	FS	
Bass	Cass						
Margaret	Cass	4.3	wq	63	E	NS	
wq = water quality data is available							
O = oligotrophic; M = mesotrophic; E = eutrophic							
FS = fully supporting; ST = supporting but threatened; NS = not supporting							
Data for Lake Bemidji and Cass Lake will be included at a later date.							

Mississippi River Basin: Headwaters to St. Croix River

2004 Impaired Waters List: Bioaccumulative Toxics
(per Section 303(d) Clean Water Act)

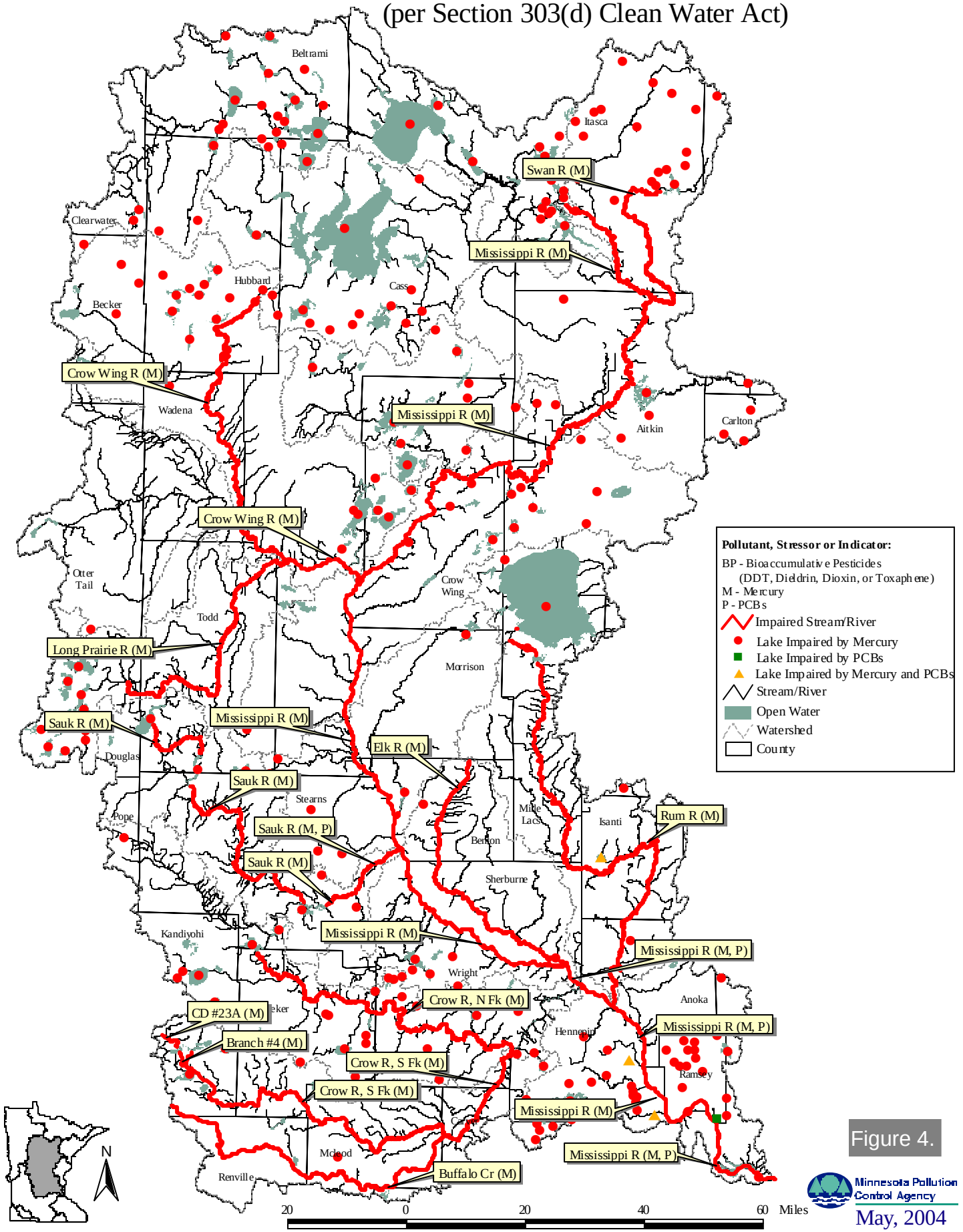


Figure 4.

Minnesota Pollution Control Agency

May, 2004

Mississippi River Basin: Headwaters to St. Croix River

2004 Impaired Waters List: Conventional Parameters
(per Section 303(d) Clean Water Act)

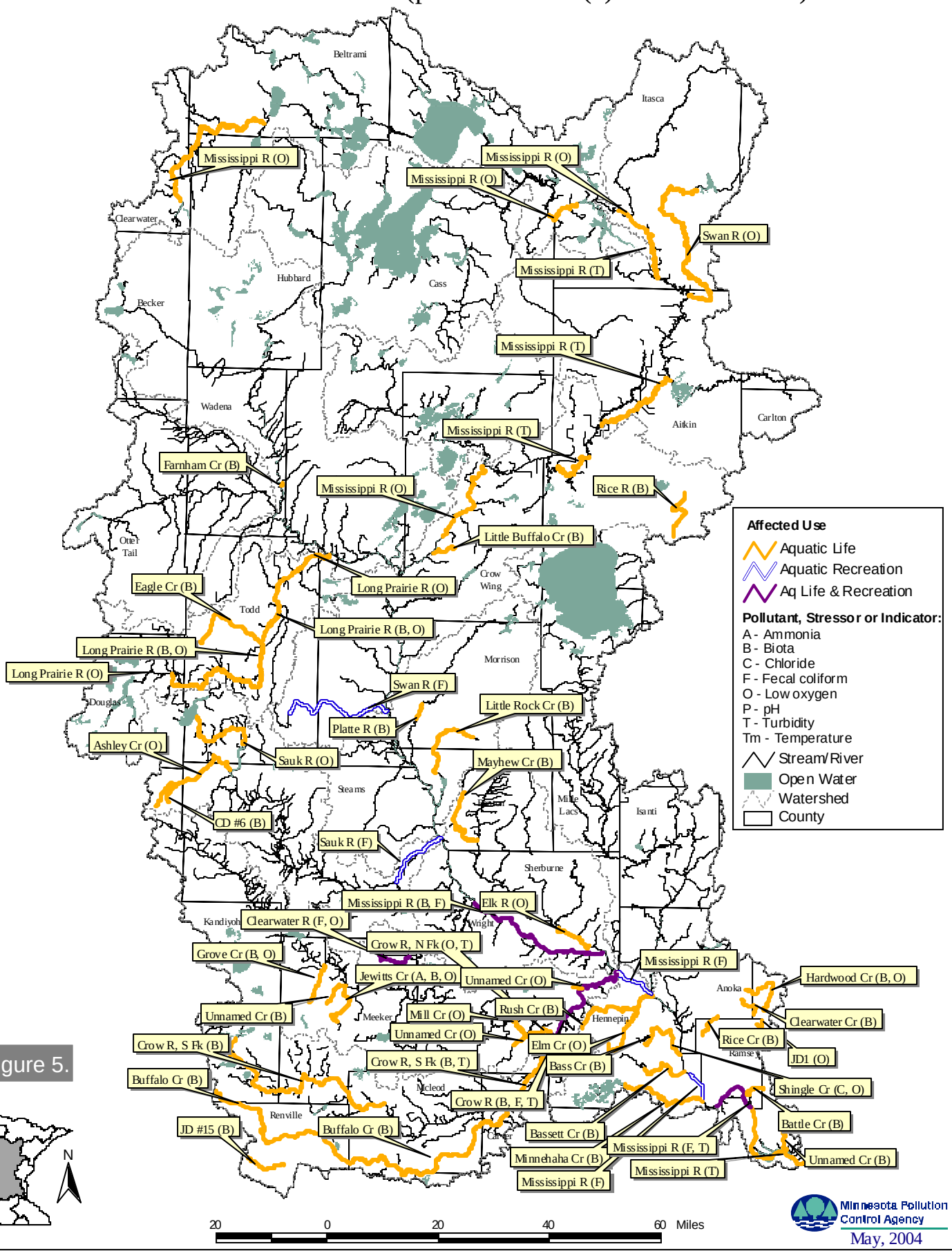


Figure 5.

Minnesota Pollution Control Agency

May, 2004

CULTURAL RESOURCES

The Corps must consider cultural resources during the planning process. The requirements are set forth in a myriad of laws, regulations, and executive orders such as the National Historic Preservation Act of 1966 (Public Law [PL] 89-665), as amended; the National Environmental Policy Act of 1969 (PL 91-190); the Archeological and Historic Preservation Act of 1974 (PL 93-291); the Advisory Council on Historic Preservation (Council) "Regulation for the Protection of Historic Properties" (36 CFR Part 800); and the applicable Corps regulations.

Federal agency compliance is based primarily on Section 106 of the National Historic Preservation Act as implemented by the Council's regulation found at 36 CFR Part 800. Under that regulation, the Corps must allow the Council an opportunity to comment on any action that has the potential to affect historic properties. That is, if an action has the potential to affect historic properties, it triggers the Section 106 review process. A historic property is any site, building, structure, or district that is listed, or considered eligible for listing, on the National Register of Historic Places. The steps outlined below must be followed during the review.

- All properties under the direct or indirect control of the Corps, or all areas potentially affected by a Corps undertaking, must be inventoried for cultural resources. That is, all fee-title and flowage-easement land as well as all property affected by the Corps' operation of the Headwater reservoirs must be surveyed using current survey standards.
- All properties identified as potentially eligible for the National Register of Historic Places (NRHP) must have their eligibility formally evaluated in consultation with the Minnesota State Historic Preservation Officer/Tribal Historic Preservation Officer, Indian tribes that may attach religious or cultural significance to the property, and other interested parties.
- The Corps must apply the criteria of adverse effect to all of the properties considered to be eligible or formally listed as a result of those NRHP evaluations in consultation with the above referenced consulting parties.
- The adverse effect on each property considered to be adversely affected must be resolved in consultation and the resolution of that adverse effect must be set forth in a Memorandum of Agreement among the consulting parties and the Advisory Council on Historic Preservation if they choose to be involved.
- All adverse effects must be resolved before the Corps can be considered in compliance.

Fortunately, the ACHP regulations provide for the development of alternate procedures that may be substituted for the ACHP regulations for the purpose of the Agency's compliance with Section 106. The alternate procedures will take the form of a Programmatic Agreement. The ACHP and the Federal agency may negotiate a

Programmatic Agreement to govern the implementation of a particular program or to resolve adverse effects from certain complex project situations when:

- The effects on historic properties are similar and repetitive or are multi-state or regional in scope.
- The effects on historic properties cannot be fully determined prior to approval of the undertaking.
- Or where circumstances warrant a departure from the normal Section 106 process.

The Headwaters reservoirs are geographically positioned in the northern central lakes area of Minnesota and at the head of North America's largest river, the Mississippi. The area has been a focus for human occupation and activity for 10,000 years or more. The archaeology of the Headwaters region plays a central role in understanding cultural development through the millennia, not only in the central lakes region of Minnesota, but also in the prairie-plains region to the west and the boreal forests to the north as well as the eastern woodlands and southern reaches of the Mississippi River. The archaeological sites located on the Headwaters reservoir lakes represent an irreplaceable legacy that needs to be preserved for future generations.

Hundreds of archaeological sites are known to exist along reservoir shorelines and downstream river reaches, which are affected by reservoir operation. Most of these sites have been adversely affected to some extent by reservoir operations. The extent of the damage to these resources by reservoir operations has not been assessed, but along the reservoir shorelines, considerable erosion and inundation of archaeological sites has occurred. The effects of reservoir operations along downstream river reaches are not well understood, but must be an important consideration for ongoing operation of the reservoirs under the present operating plan as well as any proposed changes to the plan.

In the late 1970's, the St. Paul District, Corps of Engineers conducted a series of reservoir shoreline surveys at all six reservoirs. The surveys were successful in locating a considerable number of sites and providing recommendations for future work. Most of the recommendations concerned the evaluation of eroding archaeological sites that were identified during the surveys. In very few instances has there been any follow-up on the recommendations from those surveys.

Since that time, there has been little systematic cultural resource work in the Headwaters, with the exception of work completed by the Chippewa National Forest and the Leech Lake Band of Ojibwe and centers on Leech Lake and Lake Winnibigoshish areas. Most of the ROPE study area has never had systematic survey, and large portions of the Corps' Headwaters Project as defined by flowage easement and fee-title lands has not been surveyed.

As historic preservation under Section 106 has continued to evolve, greater emphasis has been placed on tribal consultation. Through the ROPE study, the Corps is addressing both Tribal Trust issues and issues pertaining to Traditional Cultural

Properties that may exist within areas affected by reservoir operations. The Tribal Trust issues will be addressed in the Tribal Interest portion of the ROPE study.

A Traditional Cultural Property is a site or place that any group of people may consider culturally or religiously important. This site or place may be considered a historic property if it is eligible for listing on the National Register of Historic Places. This property type would be considered eligible if it plays a significant role in the ongoing traditions of the group and is important in maintaining their social and cultural fabric, traditions, and group identity.

As part of the cultural resources review for the EIS, the Corps will assess the status of cultural resource work in the Headwaters and the Corps' compliance with Federal law and regulation. The assessment will be used in drafting a Programmatic Agreement and Historic Property Management Plan for the Headwaters Project that will bring the Corps into compliance with Federal law. This will be necessary even if the recommended alternative is no action. The present operation is adversely affecting historic properties, and any reasonably foreseeable change in operations may also adversely affect historic properties.

Tribal Interest

Tribal Trust is much broader in scope and is not necessarily addressed in a Section 106 review. The issues go beyond historic preservation. Tribal Trust is driven by a set of principles, legal concepts, laws, memoranda, and executive orders that outline the responsibilities of the Federal Government to protect Indian property and lands, rights, and resources.

The ROPE study is addressing Tribal Trust through consultation and contracts with the Leech Lake Band and the Mille Lacs Band of Ojibwe to obtain general descriptions of the natural resources traditionally used by the Tribe/s or cultural resources that could be adversely affected, or benefited, by changes in lake or river management the study area.

It is critical to the overall ROPE study progress that Tribal interest be accurately identified early in the study process so that the ROPE Delivery Team can fully incorporate tribal interest data into the optimization and simulation modeling that will help in the formulation of new operating plans for the Headwater reservoirs. The intent is to generate operating plans that would not affect Tribal Trust responsibilities and may benefit tribal interests.

It is important to note that, in addition to incorporating the Tribal Interest Inventory into the model, the Tribes will be asked to provide review comments on the draft ROPE study report and EIS, and that the results of this contract will in no way affect the ability of the Tribe to comment on the ROPE study findings and recommendations.

FUTURE WITHOUT PROJECT CONDITION

The future without project condition is defined as the condition in the future 25 years from the present with the current reservoir operating plans remaining unchanged except for minor modifications as have been implemented in the past.

PHYSICAL SETTING

Sedimentation/Bank Erosion

Shoreline erosion would continue to be a problem, especially at Lake Winnibigoshish and Cass Lake. This would result in a continued loss of shoreline habitat, property, scenic beauty, and redistributed sediment covering rocky lake bottom. Cultural resource sites at eroding shorelines would continue to be affected. Projects to stabilize shoreline, likely using rock riprap, would continue to be implemented.

Climate

For the purposes of the ROPE, it is assumed that the climate will not change appreciably in the next 25 years.

OPERATION/WATER CONTROL

The existing Water Control Plan would remain in place with occasional minor changes due to adaptive management. With an increasing population and recreational use, there would likely be more demand for increasingly stable, and either higher or lower average, water levels at the reservoirs.

SOCIOECONOMIC RESOURCES

The Corps of Engineers operating plans control the lake levels on six reservoirs that influence over 50 lakes within the northern portion of the basin and the related stream flows below the dams. The positive and negative impacts associated with the current operations would continue into the future.

The principal effects on land use and area economy, from the construction and operation of the reservoirs, have varied with the changing needs of the area and with the changing Congressional mandate governing the operation.

At the Pine River Reservoir where the dam has affected the connection of a series of isolated lakes, thereby improving boating, lakeshore real estate values are higher than they are around comparable smaller isolated lakes.

The present operation of the dams and reservoirs supports the regional trend toward tourist-oriented activities. Past surveys of business owners in communities near

the reservoirs indicated that a significant portion of the summer retail business is attributable to tourists. The operation of the reservoirs is responsible for an increased share of this increased business.

Socially, the prominent trend has been away from a basic production economy to a tourist-oriented one. Families used to trying to earn a hard living from products of a not so fertile land (timber, farm crops) are being replaced by small businesses catering to the recreation and leisure-time interest of more affluent outsiders attracted by the natural beauty of the region.

Recreation use of the region is expected to continue to increase in the future along with its associated socioeconomic impacts to the local and regional economy.

Flood Damage

Two future without project conditions are planned for evaluation within the ROPE study regarding flood damage protection. One assumes there is no change from the current condition regarding operations, and damages similar to those that have occurred in the past will occur in the future, with adjustments for further development. The other assumes that a flood control project is constructed for Aitkin. This scenario would reduce the need to provide flood control benefits for the urban portion of Aitkin, thereby allowing a greater opportunity to optimize the operation of the reservoirs for the benefit of other resources. For example, reduced flood control needs at the urban portion of Aitkin may allow for operation that would simulate a more natural flow condition and/or greater flood protection around the reservoirs.

Hydropower

The existing winter drawdown plan would remain in place. The fall/winter drawdown flows from the Headwaters dams, and subsequently the downstream flow duration, would remain unchanged along with the average economic benefit to the downstream hydropower dams.

Recreation

Recreational use of the region would continue to increase, as would the development of related support facilities. Riparian development/redevelopment would continue as the heretofore undesirable areas are developed and formerly seasonal cabins are replaced with larger, fully landscaped year-round residences. The larger resorts/conference centers likely continue to add units and facilities.

Non-riparian areas also would face development pressures as the communities within the region grow with new businesses and residents. Also, there would be increased demand for non-water-related recreational opportunities, such as trails and golf courses.

With more of the land being developed, the amount of land available for hunting would decrease with a result of increased hunter density, lower success rates, and degraded recreational experience. Similarly, the increasing population within the region means there would be more individuals fishing on the lakes, causing density-related conflicts and lower success rates.

The fastest growing wildlife-related activity is wildlife observation. Birding trails have been established within the region. Basically, these are routes along highways and county roads passing various habitats that provide opportunities to view wildlife. These routes provide corridors of economic opportunities for related businesses and depend on quality habitat to provide a reasonable chance of successful observation (meeting the needs of the user). As noted above, as the land in the region continues to be developed and fragmented, the overall quality of the habitat will decline.

As recreational uses and equipment continue to evolve, so will conflict and controversy surrounding the changes. Past and current examples include snowmobiles and cross-country skiers, ATV use on public lands, and personal watercraft.

It has been shown that the Corps operating plans have resulted in unnatural flows, negatively affecting the instream environment. These conditions would continue. The existing and potential diversity of the habitat will continue to decline. As a result, the recreational potential would decline.

NATURAL RESOURCES

The future condition of the natural resources within the project area is difficult to assess, even with the use of complex studies. Here, some general ideas of how conditions may change are briefly discussed; however, little or no supporting evidence was cited in this report. Rather, most conclusions were based on the professional judgment of natural resource scientists. Future iterations will include more in-depth discussions and cited evidence to further support assumptions.

Aquatic Habitat

The quality and quantity of suitable aquatic habitat would likely decline due to continued shoreline erosion and sedimentation; declining vegetation beds due to stable water levels, erosion, and shoreline development; and continued impacts on habitat caused by winter drawdown. The actual quantity of littoral area in each of the reservoirs is not likely to change appreciably; however, the quality of the littoral area habitat would likely decline. The current effects of an unnatural flow regime would continue to negatively affect riverine habitat in the study area.

Wetland/Floodplain Habitat

Sedge meadow habitat would likely continue to decline due to the altered hydrologic regime. Invasive aquatic species such as hybrid cattail would further dominate emergent wetland habitat. Wetland habitat total acreage would likely decline somewhat due to increasing development pressure. The remaining wetland habitat would become increasingly valuable for wildlife and as potential sites for human development. It seems unlikely that many habitat improvement projects would be completed downstream from the reservoirs because such projects would not provide all the needed benefits due to ongoing altered hydrology.

Terrestrial/Upland Habitat

Development pressure would have the greatest impact on terrestrial habitat. Existing habitat would likely be further fragmented by suburban housing developments. Otherwise, there would be little change from the existing condition.

Fish

The fishery of the study area would be subjected to increasing harvest pressure as a result of population growth and an increase in recreational use of the resource. Decreases in habitat quality may lead to lower recruitment levels and an increased need for stocking. Species composition would remain similar to what it is now, but some species that are relatively rare, such as greater redhorse, pugnose shiner, and the least darter, may be extirpated from some areas. It seems likely that river fisheries may remain relatively unchanged, but increases in fishing pressure would likely occur. This could also lead to a need for increased stocking efforts on the rivers, especially in the southern portion of the study area.

Mussels

The continued operation of the dams and maintenance of the reservoirs will continue to impede fish passage, thus limiting mussel dispersal, possibly resulting in genetically isolated and disjunct mussel populations. Much is unknown of the fish host requirements of mussels, but mussels with a species specific fish host may not be able to reproduce, whereas a generalist mussel species may thrive. Perhaps the biggest threat to mussels is the potential invasion of the exotic zebra mussel (*Dreissena polymorpha*).

Birds

There is currently a great concern regarding decreasing waterfowl numbers in the study area and in the United States in general. The continued loss of wetland habitat in the HUMR would have a negative effect on waterfowl numbers for other bird species dependent on this habitat type. The yellow rail, listed as a species of special

concern in Minnesota, inhabits the study area and would be affected by further decreases in wetland habitat quality and quantity.

Mammals

Aquatic mammals such as muskrats would continue to be affected by the unnatural flow regime and by decreasing wetland habitat.

Threatened and Endangered Species

It is difficult to say anything specific about existing species and their likely condition 25 years from now. The current operation of the Headwaters reservoirs would continue to have an impact on those species that is similar to the existing condition. The U.S. Fish and Wildlife Service downlisted the gray wolf to threatened in 2003, and it is reasonable to expect it to be delisted in the study area within 25 years. The bald eagle has made a remarkable recovery since the ban on DDT, and it is reasonable to expect it to also be delisted within 25 years. The status of the Canada lynx is not likely to change. It is likely that other species within the study area will be listed, but it is difficult to speculate which ones.

Biological Productivity

The change in biological productivity for the future without project condition would likely be minor in most cases. It is possible that there would be an increase in productivity in reservoirs if nutrient inputs increase with increasing development. This increased productivity would likely lead to algal blooms and decreased water clarity unless the submerged vegetation was able to outcompete the algae. It is difficult to say how it would affect the aquatic communities or the fisheries. An increase in productivity could benefit game species; however, it could harm the fishery if it favored undesirable species.

Biological Diversity

Biological diversity would likely decline further by the local extirpation of sensitive species that are being stressed by the current reservoir operation.

Water Quality

Reservoir operation would continue to affect water quality in a manner similar to the existing condition.

CULTURAL RESOURCES

The operation of the Headwaters reservoirs has adversely affected hundreds of archaeological sites and would continue to affect these archaeological resources under the present operating plan.

PLATES

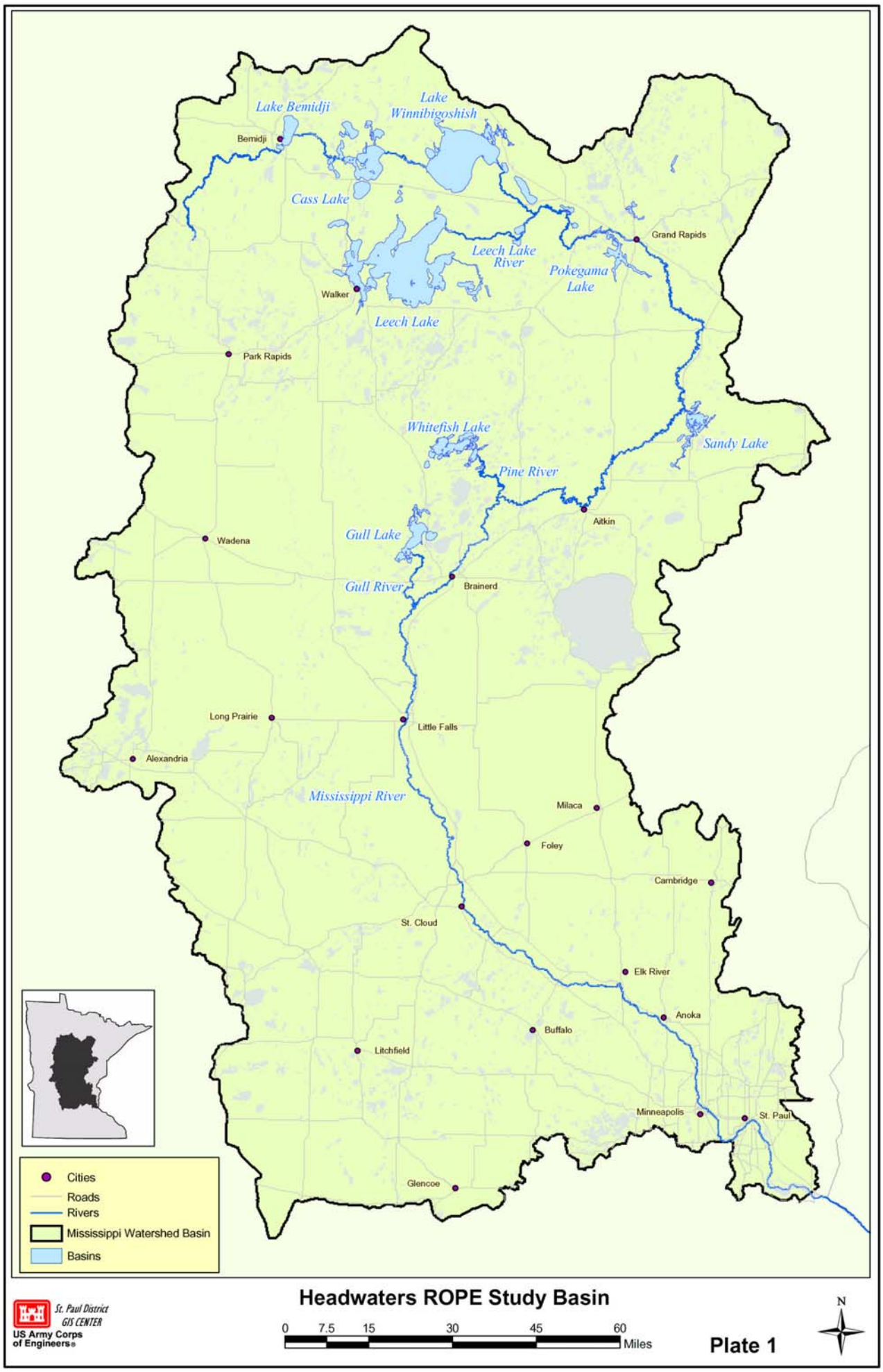

Lake Bemidji
Lake Winnibigoshish
Bemidji
Cass Lake
Grand Rapids
Leech Lake River
Pokegama Lake
Walker
Leech Lake
Park Rapids
Whitefish Lake
Sandy Lake
Pine River
Aitkin
Wadena
Gull Lake
Gull River
Brainerd
Long Prairie
Little Falls
Alexandria
Mississippi River
Milaca
Foley
Cambridge
St. Cloud
Elk River
Anoka
Buffalo
Litchfield
Minneapolis
St. Paul
Glencoe
Cities
Roads
Rivers
Mississippi Watershed Basin
Basins
St. Paul District GIS CENTER
US Army Corps of Engineers
Headwaters ROPE Study Basin
0 7.5 15 30 45 60
Miles
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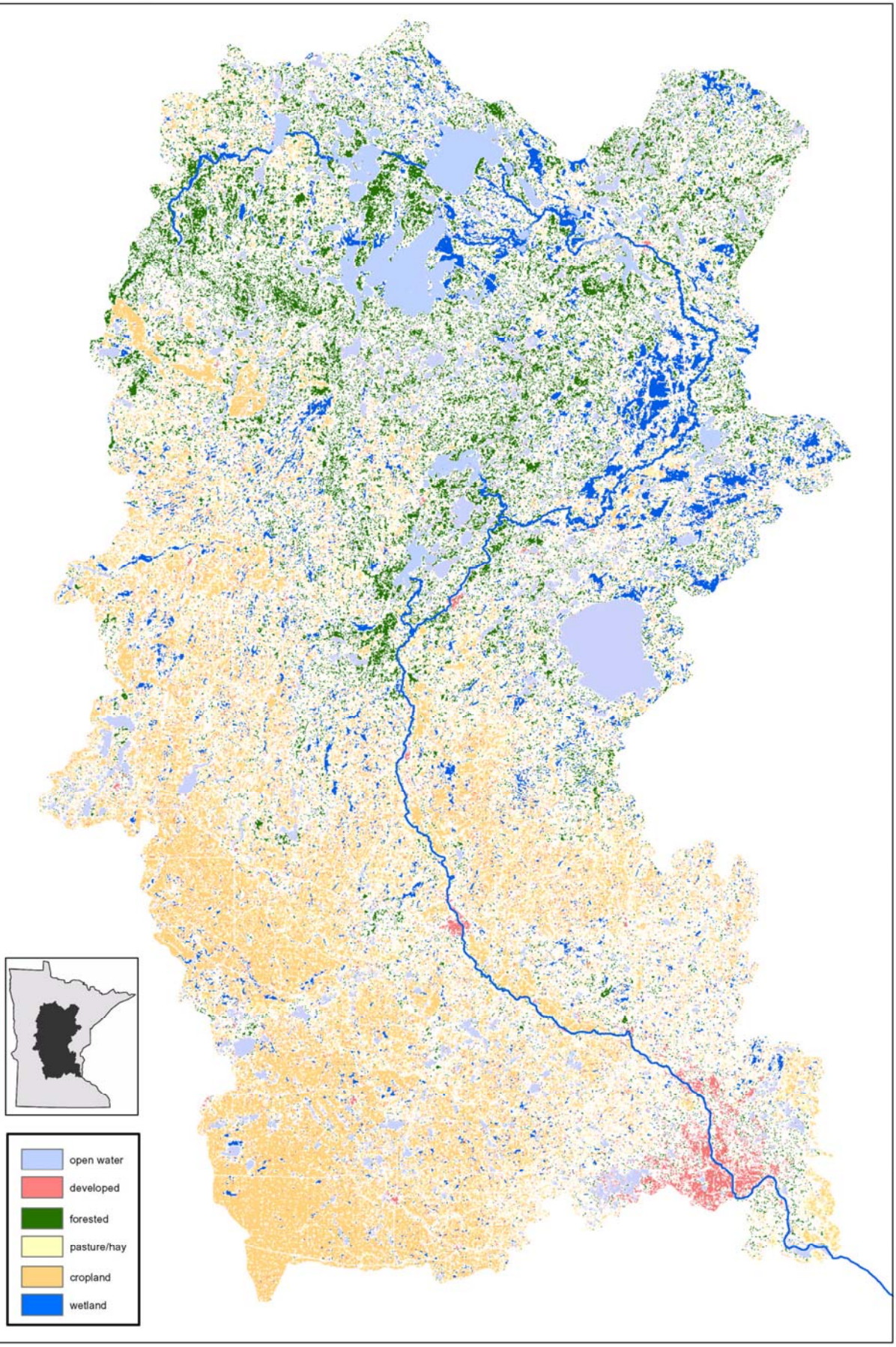
Plate 1



St. Paul District GIS CENTER
US Army Corps of Engineers

Headwaters ROPE Study Basin

0 7.5 15 30 45 60 Miles

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Plate 2